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NOTE.—Illustrated articles are marked with an (*) asterisk.

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International Marine Engineering

JANUARY, 1909.

RECENT ADDITIONS TO THE ENGLISH FLEET.

With the launch at the Devonport dockyard on Nov. 7, 1908, of the battleship *Collingwood*, England now has in the water, including the ships of the *Inflexible* class, nine *Dreadnoughts*. One more will probably be launched the first of the year, and two others, which were authorized in the naval estimates of 1908-1909, will probably be laid down soon after the first of the year, so that by 1911 Great Britain will have in commission a fleet of twelve ships of the *Dreadnought* class aggregating about 169,350 tons.

The *Collingwood*, which, with the *St. Vincent* and *Vanguard*, was authorized in the naval estimates of 1908-1909, was laid down Feb. 3, 1908, and is to be completed Feb. 3, 1910. Her principal dimensions are: Length (waterline), 530 feet; beam, 84 feet; mean draft, 27 feet; with a displacement of 19,250 tons, or 1,350 tons more than the original *Dreadnought*. She is to be propelled at a speed of 21 knots by four screws, driven by Parsons turbines, the steam for which is supplied by Yarrow large-tube boilers. The total designed horsepower of the turbines is 24,500, and the arrangement of the turbines will be practically the same as that on the *Dreadnought;* that is, each of the outboard shafts will be driven by one high-pressure ahead and one high-pressure astern turbine, while the inboard shafts will have three turbines each, namely: the low-pressure ahead and low-pressure astern and cruising turbine. Provision is made for 900 tons of coal at normal displacement and 2,000 tons at full-load displacement. Oil fuel is also to be carried, and the boilers are to be equipped for burning both oil and coal.

All that can be stated definitely regarding the armor of this vessel is that the main belt is to be 11 inches thick amidships. The total number of guns which the *Collingwood* will carry has not been made public, but it is understood that her battery will consist of ten 12-inch guns, 45 calibers long instead of 50 calibers, as has been frequently reported; while her secondary battery will probably consist of sixteen or twenty 4-inch rapid-fire guns and several machine guns.

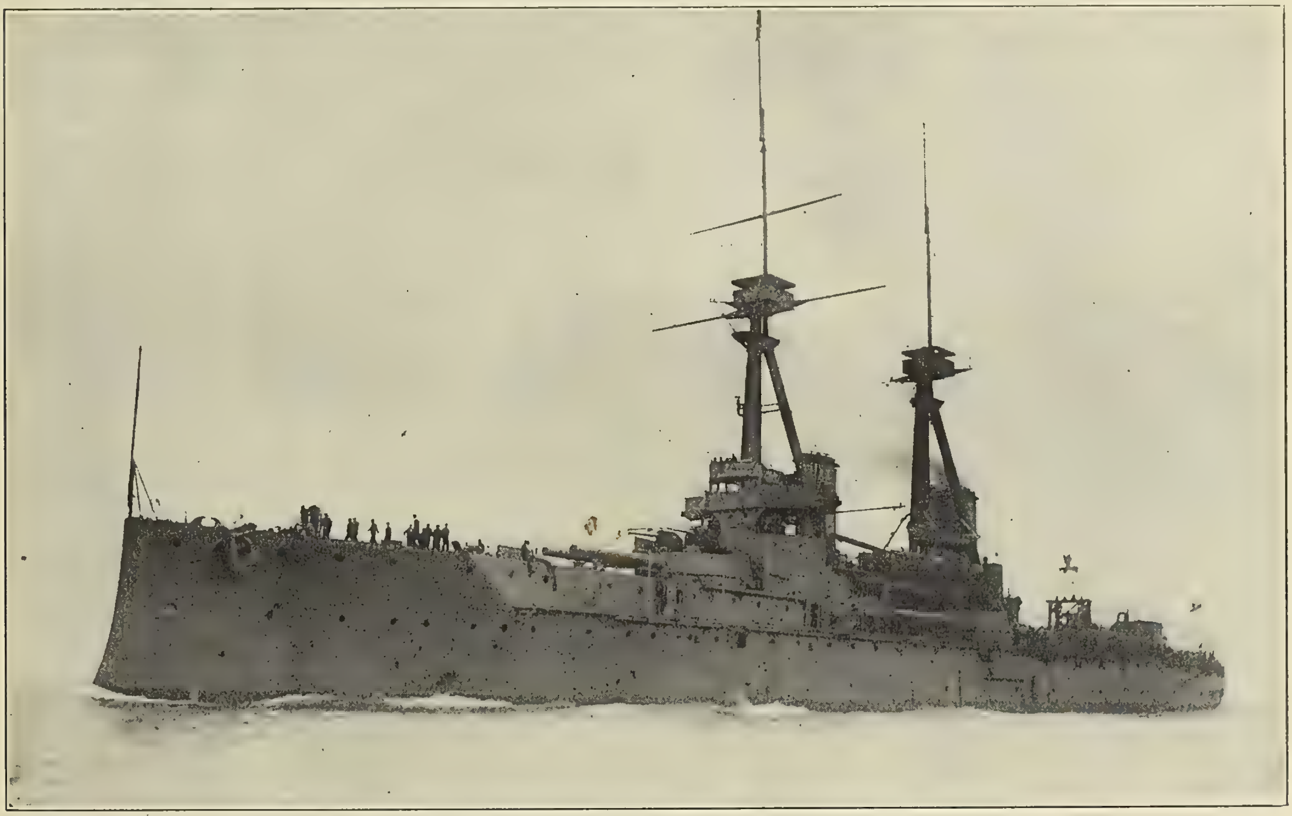


FIG. 1.—H. M. S. BELLEROPHON LEAVING PORTSMOUTH DOCK-YARD FOR HER OFFICIAL TRIALS.

The first battleship of this class to be launched was the *St. Vincent*, which is being built at the Portsmouth dock yard. She was laid down in December, 1907, and is similar to the *Collingwood* in all respects except that she is to have Babcock & Wilcox boilers in place of the Yarrow type. The third ship of this class, the *Vanguard*, is being built at Barrow by Vickers Sons & Maxim. Work has progressed on the *Vanguard* to such an extent that she could be launched at any time but for the widening of the passageways to one of the docks. While little is known regarding the details of this ship, it is thought that she is to have a slightly larger displacement than the other two. The propelling machinery is

to be the same as that of the *Collingwood,* with the exception that Babcock & Wilcox boilers are to be installed in place of the Yarrow type. Not only is the hull and machinery of this ship being constructed by Vickers Sons & Maxim, but the guns and armor as well, so that the entire ship down to the smallest detail will be the production of this company.

Only one of the three improved *Dreadnoughts* authorized in the naval estimates of 1906-1907 has been completed, and that is the *Bellerophon.* The construction of the other two ships of this class, the *Téméraire* and *Superb,* has been delayed somewhat on account of strikes on the Northeast coast, where the machinery is being built. The details of these ships can be stated more definitely than those of the *St. Vincent* class. Their normal displacement is 18,600 tons, or 650 tons less than that of the *St. Vincent* class. The length on the waterline is 520 feet; the beam, 82 feet; the mean draft, 26 feet 3 inches. The armament consists of ten 12-inch guns, 45 calibers long, and sixteen 4-inch quick firers. There are four submerged broadside torpedo tubes, and one submerged torpedo tube at the stern. The waterline armor belt is 11 inches thick amidships, tapering to 6 inches forward and 4 inches aft. The upper belt is from 8 to 6 inches thick, while the turrets are protected by 8-inch armor and the barbettes by 12-inch armor. The protective deck is 2¾ inches thick on the slopes and 1¾ inches thick on the flat. The main engines of these ships are Parsons turbines, having a total horsepower of 23,000, designed to drive the ships at a speed of 21 knots. The coal capacity is the same as that in the *St. Vincent* class. Babcock & Wilcox boilers are fitted on the *Bellerophon* and *Superb* and the Yarrow type on the *Téméraire.*

It is reported that on her recent trials the *Bellerophon* attained a speed of 19 knots on four-fifths of her designed horsepower, and that on her eight-hour full-power steam trial she averaged 22 knots, the total horsepower of the turbines being 23,000.

Many rumors have been current regarding the design of the new *Dreadnought* provided for in the estimates of 1908-1909, and which is soon to be laid down at the Portsmouth dockyard. The probabilities are, however, that this ship, which is to be named the *Foudroyant,* will not be equipped with the 13.5-inch gun which many have predicted, but will retain the 12-inch gun, and in design will be simply an improved *St. Vincent* rather than a radical departure from this type. It is likely, however, that the arrangement of the 12-inch guns will be changed, not only so that all ten guns can be fired on a broadside, but also so that the guns of the middle center line turret can be fired over the after turret, as is the case on the *South Carolina* of the United States navy, and on the new Brazilian battleship *Minas Geraes.* If the turrets are to be so arranged that all the 12-inch guns can be fired on either broadside, it will mean that the two center turrets, which, in the *St. Vincent* class, are placed opposite each other on either beam, must be mounted *en echelon,* as on the *Inflexible* class. In this case it is probable that these two turrets would be on the same level as the forward turret on the forecastle. The manner in which the guns on the *Inflexible* class can be trained on either broadside is well illustrated in Fig. 4, which shows the upper deck of the *Indomitable.* The arc of fire for the guns arranged in this way is somewhat limited when trained across the ship, but it is sufficient to make them available for broadside fire.

Turning now to the powerful cruisers of the *Inflexible* class, which we have included in the squadron of *Dreadnoughts* on account of their great speed and heavy gun power, we find that, with the exception of the one provided for in the estimates of 1908-1909, all of these battle cruisers have been

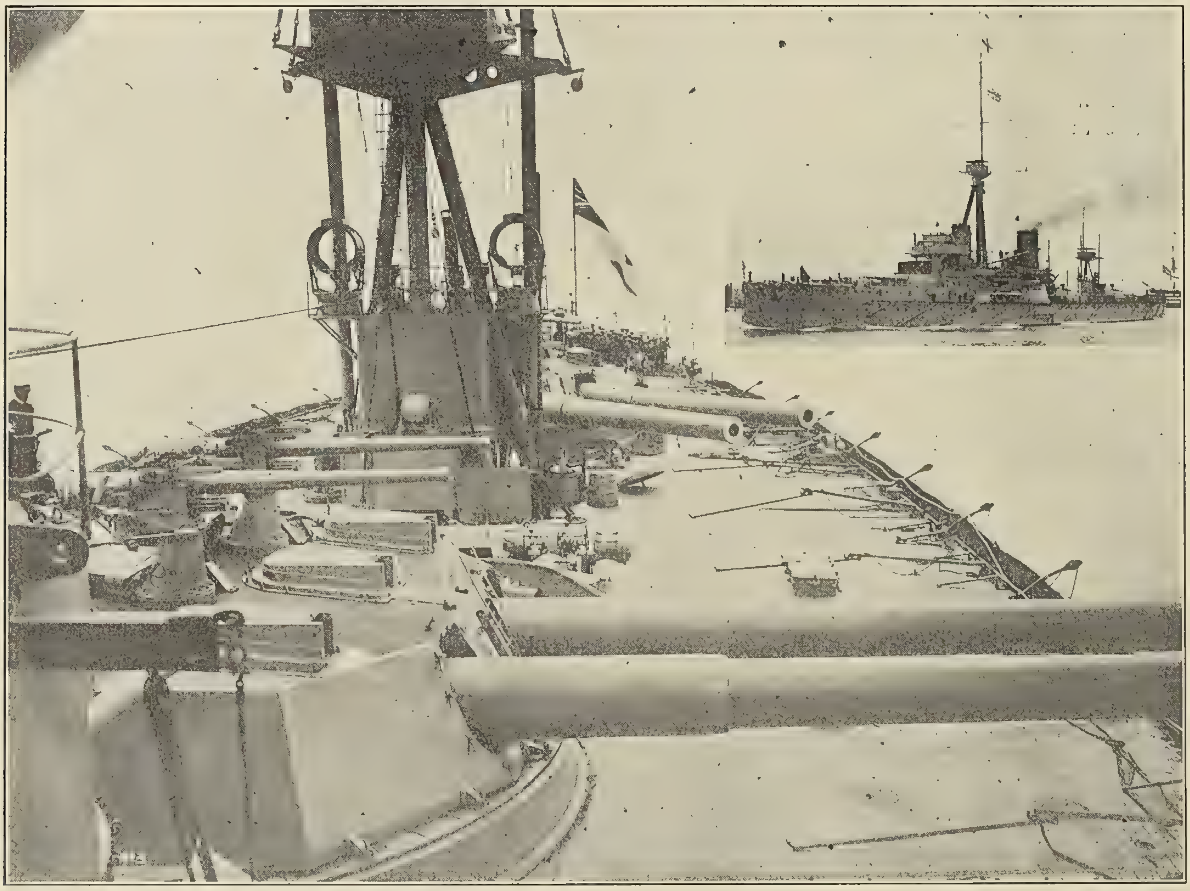


FIG. 2.—H. M. S. DREADNOUGHT AND A VIEW OF HER AFTER-DECK CLEARED FOR ACTION.

FIG. 3.—THE BATTLE CRUISER INDOMITABLE.

completed and have finished their trials. The *Indomitable*, which has been described at some length in previous issues of this magazine, has been in service long enough to attain a world-wide record for speed. The *Inflexible*, built at the Clydebank yards of John Brown & Company, was commissioned Oct. 20 at Chatham; while the *Invincible*, built by Sir W. G. Armstrong, Whitworth & Company, Newcastle-on-Tyne, has just carried out her trials. She is reported to have attained a speed of 25 knots on seven-tenths of her full power, and a speed of 28 knots on her eight-hour full-power trials.

These ships are not only the longest warships afloat but also the fastest and most heavily armed cruisers in the world. Their displacement is 17,250 tons; they have a length on the waterline of 560 feet; a beam of 78½ feet, and a draft of 26 feet. Parsons turbines, designed for a total horsepower of 41,000, have been installed in each ship, steam being furnished by Yarrow watertube boilers in the case of the *Inflexible* and *Invincible*, and Babcock & Wilcox boilers in the case of the

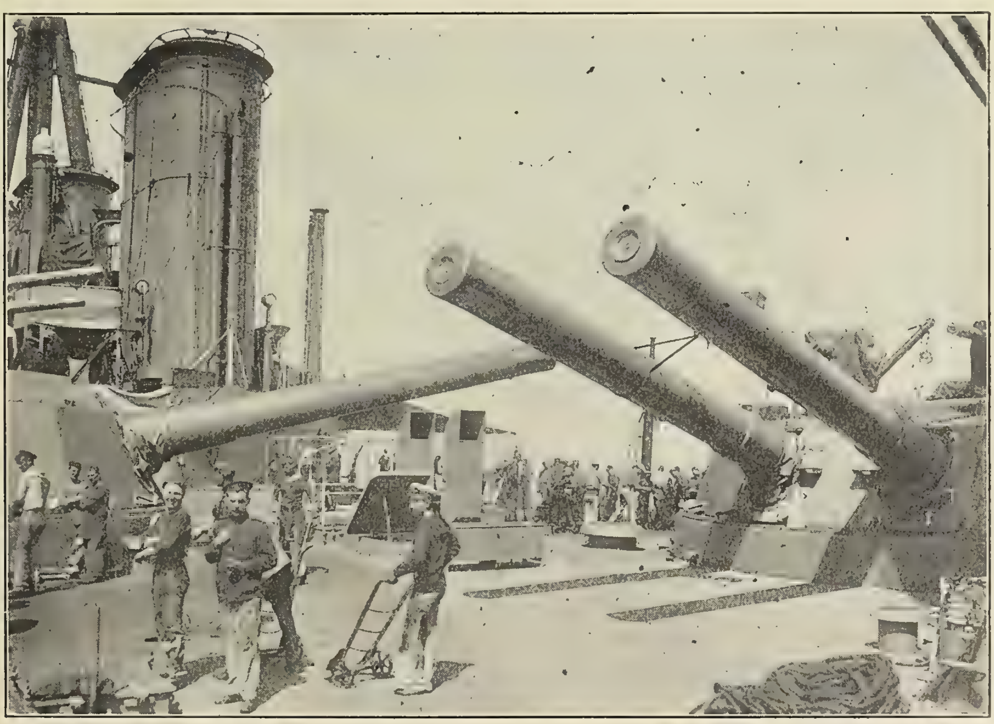


FIG. 4.—UPPER DECK OF THE INDOMITABLE, SHOWING MANNER IN WHICH 12-INCH GUNS CAN BE TRAINED ACROSS THE SHIP.

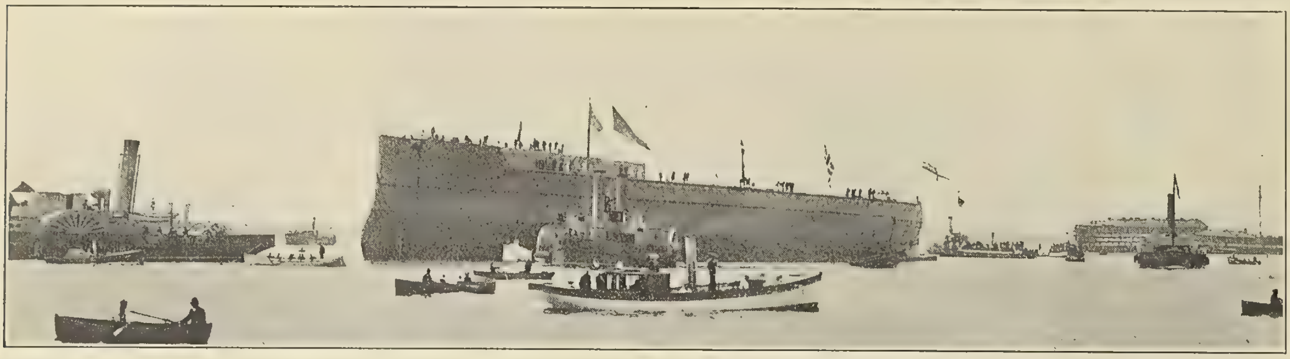


FIG. 5.—LAUNCH OF H. M. S. ST. VINCENT AT THE PORTSMOUTH DOCKYARD.

Indomitable. Designed for a speed of 25 knots, all three ships have greatly exceeded this speed on their trials. The normal supply of coal is 1,000 tons, and the maximum supply, 2,000 tons; oil fuel is also carried, and the boilers are designed to use oil in conjunction with the coal.

The armament of these vessels, which is the main reason for classing them as *Dreadnoughts,* consists of eight 12-inch guns 45 calibers long, mounted in pairs in turrets, so that all eight guns can be fired on either broadside, and six of them either directly ahead or directly astern. The secondary battery consists of sixteen 4-inch rapid-fire guns and also three submerged torpedo tubes. The heaviest armor is 7 inches thick at the waterline amidships. This tapers to 4 inches at the bow.

It is interesting to note that the old *Inflexible,* which was a ship of 11,880 tons, 13 knots' speed, built in 1875, was one of the first warships to have her guns mounted *en echelon.* She carried four large guns in pairs in turrets, the starboard pair being ahead of the port pair. This condition is repeated in the new *Inflexible* and her sister ships, where the center turrets are mounted in this manner. In the new *Inflexible,* however, this arrangement permits the guns to be fired on either broadside, whereas in the older ship this was not possible.

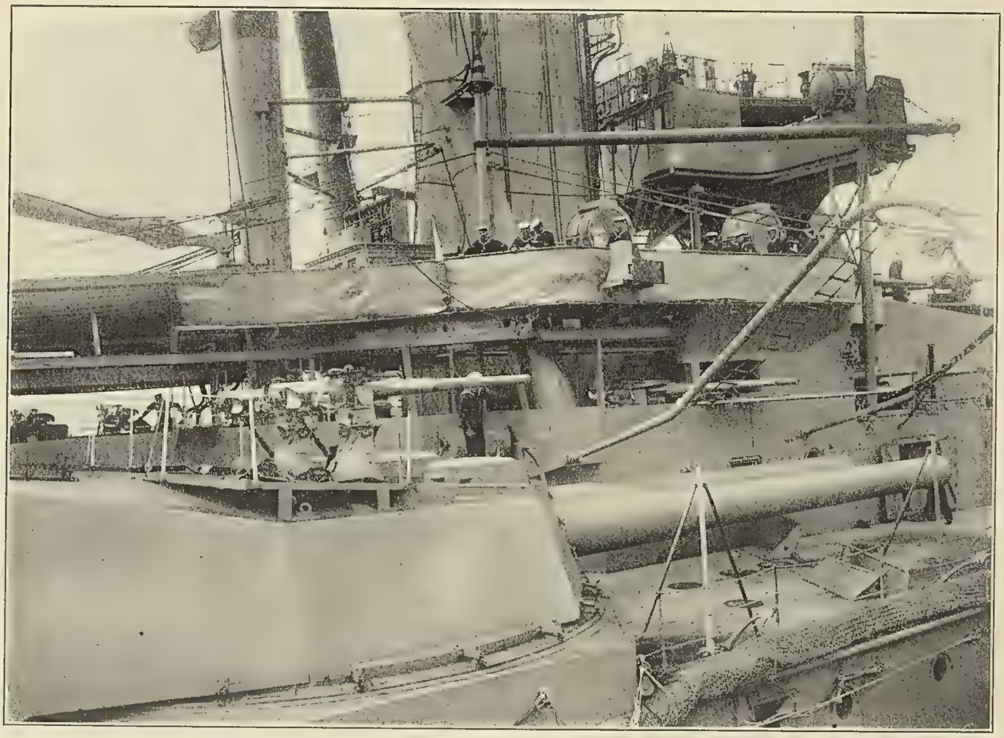


FIG. 6.—SIDE TURRETS AND BRIDGE DECK OF THE DREADNOUGHT.

Building Slips for the New White Star Liners Olympic and Titanic.

The preparations which are being made in the Belfast yard of Harland & Wolff for the building of the largest vessels afloat are noteworthy. The new White Star Liners' gross tonnage will each approximate 42,000 tons, with a displacement of 60,000 tons, as against 17,274 tons gross of the *Oceanic* and 31,938 tons of the *Mauretania.* The cost of the new liners will exceed by £50,000 ($243,325) that of the big Cunarders.

The alterations and additions which have been in progress at the yard since October, 1907, include an enormous double gantry over the two new slips on which the keels are to be laid, the erection of a floating crane, and the introduction of the most modern hydraulic and pneumatic plant, electrically driven. Improvements have also been carried out in various departments of the shipbuilding and engineering sections.

The great double gantry is now nearing completion in the north yard, which is to be utilized in the building of the hulls. This structure, which has been erected by Sir William Arrol & Company, Glasgow, the builders of the Forth Bridge, consists of three vertical steel structures, placed directly over the three berths on which the firm's largest vessels have been

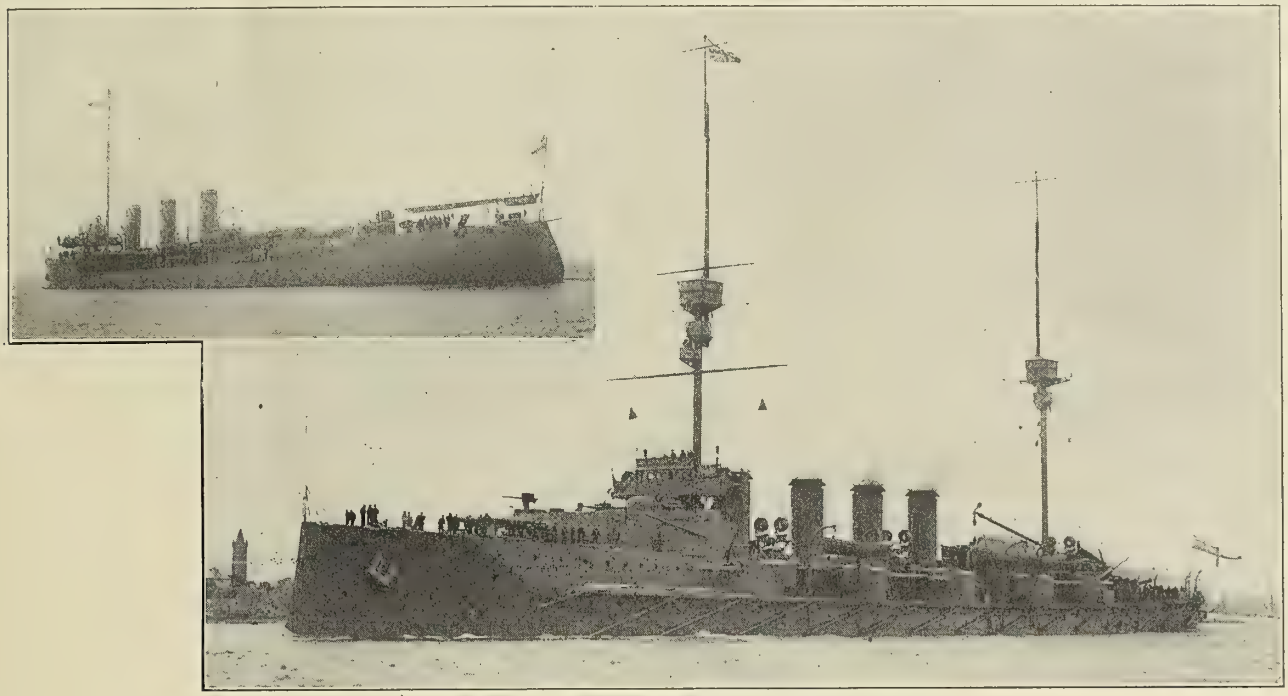
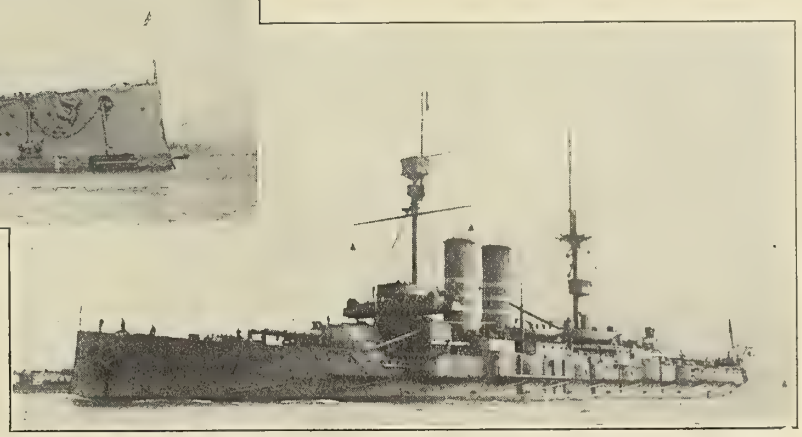


FIG. 7.—25-KNOT SCOUT CRUISER FORWARD AND ARMORED CRUISER MINOTAUR.

built. These three bays are being converted into two. The framework has a total length of 840 feet, with a width of 270 feet. From the yard level to the top of the cantilever crane which surmounts the structure the distance is 230 feet. The framework columns are of lattice construction, and are 80 1,070 feet long by 285 feet wide. The speed capacities are: Lifting, 250 feet; slewing, 400 feet; traveling, 200 feet, and cross traverse of the truck on the crane, 150 feet per minute. There are three overhead travelers above each berth, and each of them carries two cranes capable of handling 10-ton trucks.

BATTLESHIP BRITANNIA, OF THE KING EDWARD CLASS.



BATTLESHIP AGAMEMNON, OF THE LORD NELSON CLASS.

feet apart, with girders connecting them longitudinally. The double gantry carries twenty-three cranes, electrically driven, so placed that any part of the berths can be easily reached. The cantilever runs the entire length of the gantry, and is capable of lifting 3 tons at a stretch of 135 feet and 5 tons at a stretch of 65 feet, and carrying the loads to a height of about 180 feet from the ground at any point within a radius At a lower level there are five side-walking cranes on each gantry, with jibs of 50 feet radius, each carrying 5 tons. Two of the higher level cranes nearest the water are fitted with eyes to lift 40 tons, and these will deal with stern frames and propeller brackets. The collective strength of the motors which drive the cranes is 1,600 horsepower, and 7,000 tons of steel have been utilized in the construction of the framework

alone. The length of the two berths covered by the gantries is 1,000 feet each, and there is ground space between the north and south yards to extend them when necessary.

The construction of the berths is interesting from the point of view of magnitude. Some 10,000 piles have been driven; the piles, which are of larch, pitch pine and Oregon pine, varying in length from 30 feet to 40 feet. Near the water's edge an enormous dam has been fixed to the piles by powerful steel rods, while the tops of all the piles are reinforced by steel girders and old rails. A sheet of concrete envelops the entire surface, and at some parts it attains a depth of fully 4 feet, the incline given to the beds being sufficient to ensure launching at a safe speed.

DOCKYARDS VERSUS CONTRACTORS.

The British shipbuilding trade and those "in the know" connected with it are much interested in two recent events. One is that the Admiralty have just placed contracts with private builders in England and Scotland for five second-class cruisers and seven destroyers. These cruisers are to be of 4,000 tons displacement each, and will have turbine-propelling machinery designed for a speed of not less than 25 knots. The destroyers are to have a speed of 27 knots. Of these cruisers three are to be built on the Clyde (by Fairfield Company, John Brown & Co., and William Beardmore & Co., respectively), one by the Armstrong-Whitworth Company, Elswick-on-Tyne, and one by Vickers Sons & Maxim, Barrow. Of the destroyers, two are to be built on the Clyde (by William Denny & Bros., and the London & Glasgow Shipbuilding & Engineering Company), one by the Thames Iron-Works Company, one by Hawthorn, Leslie & Co., Tyne; one by J. I. Thornycroft & Co., London, and two by White & Co., Cowes. The cruisers will cost about £350,000 ($1,703,300) each, and the destroyers about £100,000 ($486,650) each, so that a total sum of about two and a half millions sterling ($11,900,000) is involved in these contracts.

The second item of interest is that the *Indomitable*, whose famous race across the Atlantic only a few short months ago won the applause of the world and the envy of other maritime nations, has proved a perfect disappointment after passing through Admiralty Dockyard hands at Chatham for overhaul since her return from her record-breaking voyage.

Now what is the connecting point of interest between these two items of intelligence? It is spelt in a single phrase, "Admiralty overhaul." Nobody, anywhere, doubts for a single moment that each one of the private firms will deliver the vessels recently contracted for fully up to, and even beyond, the Admiralty requirements. What the Fairfield Company, for instance, proved that they could do in the case of the *Indomitable* they will not fail to do with the new cruiser they are to build. And what the *Indomitable* could do, even before her world-famous Atlantic run, was shown by the data from her official trials which were published in the August, 1908, issue of this magazine. The speed contracted for was 25 knots, and on her official steam trials she averaged 26.75 knots, and on her long ocean run she averaged considerably over 25 knots. Since, however, she came out of Chatham hands, her speed has dropped notoriously—even to the extent (though a judicious official silence is maintained on the subject) of 5 knots below the rate contracted for.

This vessel was only taken over by the Admiralty after she had passed through a long course of official trials. These trials proved that she was perfect in every respect and more than up to contract, when handed over and formally accepted. She was placed in commission, and on her first voyage more than demonstrated the ability of the builders, and the wisdom of the Admiralty in accepting delivery. She came back from her voyage, was taken out of commission and sent to the Admiralty Dockyard at Chatham. If, then, she has now proved a failure or a disappointment in any respect, the *whole blame must be with the Admiralty.* And that is why the new contracts are being regarded askance. It is absolutely certain that the vessels now contracted for will have the desired speeds when handed over to the naval authorities, but what will they be afterwards? The new cruisers, like the *Indomitable,* are to be turbine ships, and Chatham is not the only place where they seem to know nothing about turbines.

The *Indomitable* is in more senses than one "The Ship of Mystery," as she has frequently been characterized. She is a wonderful ship, but not the least wonderful thing about her is, that she has demonstrated to Admiralty officials the grand old "circumlocution office" principle of "how-not-to-do-it." Why she was taken to bits when she was sent to the dockyard nobody knows—outside Whitehall or Chatham. If her turbines needed overhaul, the proper people to do it were the builders of them, who knew all about them—not the dockyard hands, who know nothing about turbines, and probably not much about engines of any kind. The case, indeed, just serves to revive the old complaint that contract machinery is taken to pieces at the Admiralty Dockyards just to enable the Admiralty engineers and officials to instruct themselves in their own profession—by finding out how cleverer and more experienced men do their work. The instruction is doubtless necessary and valuable—but it is extremely expensive. It is open to doubt if a contract-built ship ever went through a dockyard overhaul without coming out the worse for it. That is to say, these Government officials are much better at taking a contract engine to pieces than they are at putting it together again. If all tales are true, the *Indomitable's* turbines were more than they could manage, and yet they are about to attack the *Inflexible* in a similar manner.

It seems about time the British public wakened up to the way in which their money is being wasted at these Government establishments. A good many people in the shipbuilding trade think it would be better, and certainly cheaper, for the country if these establishments should be shut up altogether. The instance cited seems to confirm that view. Many people think it would be unwise to shut up the Government Dockyards altogether, maintaining that they should be reserved for repair work only—not for constructive work. It is just in this so-called repair work, however, that they are doing the mischief—spoiling the handiwork of people who do know their business, in order to instruct people who do not know it.

The writer is giving voice to a standing grievance in the British shipbuilding trade. It is not the engines alone that are, or may be, ruined by the pottering about and tinkering of amateurs who would be experts, but all sorts of details are interfered with. A private builder knows exactly where to get the best of everything he needs for his engine room, his boiler room, his stokehold, his shaft tunnels, and so forth. He doesn't need any Admiralty official to teach him where to get the best material for his purpose, but whenever the Admiralty official gets his finger in an overhaul he can reject wholesale—at the public expense—this, that and the other detail carefully thought out and judiciously provided by the contractors, in order to replace it with some fancy pattern supplied by some friend of his own. Each of these little details—as, for instance, boiler covering—may be small in itself, but in the aggregate they mount up and unconsciously swell the Admiralty estimates for repairs. And the trouble is, that with so much waste of money, the dockyard repair too often spells misfit.

MARINE ENGINE DESIGN.

BY EDWARD M. BRAGG, S. B.

STEAM SPEEDS AND VALVE DIAGRAM.

The steam speeds commonly given for engines are based upon the piston displacement. The volume of steam entering a cylinder is assumed to be the volume given by the product of the piston speed and the area of the cylinder. Steam speed

$$= \frac{A \times PS}{a},$$

where A is the area of the piston in square inches, and a is the area of the passage in the same units. The width of the port in the direction of motion of the valve should be from 0.6 to 0.8 of the eccentricity.

The eccentricity is usually given in inches, half inches, or quarter inches, so it is well to start the solution of the valve gear problem by assuming an eccentricity appropriate to the size of the engine.

I. H. P. of engine	500 to 1,000	1,000 to 2,000	2,000 to 5,000	5,000 to 10,000
Eccentricity:				
H. P. and M. P.....	3″ to $3\frac{1}{2}$″	$3\frac{1}{2}$″ to 4″	4″ to $4\frac{1}{2}$″	$4\frac{1}{2}$″ to 5″
L. P..............	3″ to $3\frac{3}{4}$″	$3\frac{1}{2}$″ to $4\frac{1}{4}$″	4″ to 5″	$4\frac{1}{2}$″ to $5\frac{1}{4}$″

In order that the low-pressure valve may not be too broad, when a slide valve is used, it is sometimes necessary to make the valve double ported, and to increase the eccentricity. The breadth of the passage, going from the face of the slide valve to the cylinder, must be not more than 0.85 D to 0.95 D, where D is the diameter of the cylinder. The port area necessary will depend upon the steam speeds, and the steam speeds must be selected with reference to the desired economy. The steam speeds should be about as follows for engines whose design factor is 0.7 or more:

Main steam pipe..............	6,000 to 7,200 feet per minute.
Throttle valve................	5,000 to 6,000 feet per minute.

	High-pressure Ports.	Medium-pressure Ports.	Low-pressure Ports.
Entering steam......	5,000 to 6,000	6,000 to 7,000	7,000 to 8,500
Exhaust steam.......	4,000 to 5,000	5,000 to 6,000	6,000 to 7,000
Exhaust to condenser.			6,000 to 6,500

Engines whose design factor lies between 0.7 and 0.6 can have the following steam speeds:

Main steam pipe..............	6,500 to 7,500 feet per minute.
Throttle valve................	5,500 to 6,500 feet per minute.

	High-pressure Ports.	Medium-pressure Ports.	Low-pressure Ports.
Entering steam.....	6,000 to 8,000	7,500 to 10,000	9,000 to 13,000
Exhaust steam......	5,000 to 6,000	6,500 to 8,000	8,000 to 10,000
Exhaust to condenser			7,000 to 9,000

It is best to select the speed of exhaust steam, and from this get the necessary area of ports by means of the formula:

$$a = \frac{A \times PS}{\text{speed of exhaust}}, \qquad (47)$$

where A = area of cylinder;
PS = piston speed.

The breadth of the port having been taken from 0.85 D to 0.95 D, and allowance having been made for the ribs, the width of port can be found. If this is from 0.65 E to 0.8 E, where E is the eccentricity selected, the valve can be single ported; if more than that, it will be best to make it double ported, and to decrease the breadth of port so that each port shall be from 0.65 E to 0.8 E. The speed of the entering steam cannot be selected arbitrarily, but will be determined by the maximum port opening obtained from the valve diagram.

Entering speed steam: exhaust speed:: maximum port opening: width of port.

If the speed of the entering steam does not come within the limits given, the eccentricity or the width of port should be changed.

The area of the pipe, if one is used, or of each pipe, if two are used, going from one cylinder to the next, should be intermediate between the area of the exhaust ports in one cylinder and the area of the ports at maximum port opening in the next cylinder.

When piston valves are used, the breadth of the steam passage does not have to be considered, as the steam is admitted around the circumference of the valve, and the passage can be so designed as to take care of any reasonable diameter of valve or valves. In the slide valve, allowance has to be made for two or three ribs in the passageway; so, in the piston valve, the entire circumference of the valve is not clear opening. Bridges have to be carried across, to prevent the rings of the piston valve from springing out into the passageway, and these bridges usually take up about a quarter of the circumference. Allowing for this, the diameter of the piston valve can be obtained from the formula:

$$d = \frac{D^2 \times PS \times c}{V \times W}, \qquad (48)$$

where D = the diameter of the cylinder in inches;
PS = the piston speed of the engine in feet per minute;
V = the velocity of the exhaust in feet per minute;
W = the width of the port in inches;
c = 0.333 for 0.75 of the circumference clear opening;
0.357 for 0.7 of the circumference clear opening;
and 0.312 for 0.8 of the circumference clear opening.

The lead upon one end of the valve must be assumed before the valve diagram can be started. The lead upon the top end of the cylinder is generally made about $\frac{E}{6}$, and the difference in the cut-offs is so chosen that the lead upon the bottom shall be ⅛ inch more. Both leads cannot be assumed if the cut-off positions are assumed; one lead can be assumed and the other worked out.

The eccentricity gives us the radius of the circle $ABCD$, Fig. 45. After drawing the two axes AB and CD at right angles, an arc can be struck from A with a radius equal to the assumed lead at the top. The cut-offs which were calculated for the cylinders at the very first are the mean cut-offs of the two ends of the cylinders. Equality of cut-off in percent of the stroke is never attempted in marine engines, where the ratio of connecting rod, length to length of crank, is so small that an impractical inequality of lead would result.

The cut-off on the down stroke is usually 7 or 8 percent greater than the cut-off on the up stroke. The excess of lead upon the bottom should be sufficient to allow for the greater forces to be overcome, and for the fact that, as wear takes place in the joints of the valve gear, the valve is going to drop down, and cause the lead upon the bottom to decrease.

The desired difference in lead can be obtained by laying off from the top end of the diagram a percentage of the diameter of the valve circle AF, equal to the desired mean percentage of the cut-off. A perpendicular dropped from the point F upon the valve circle will give a point through which a diameter GH can be drawn, that will give the cut-off position

of the cranks upon the down and up strokes, which will be accompanied by equal leads. The desired inequality of lead, ⅛ inch, can be obtained by laying back 1/16 inch from G to J, and forward 1/16 inch from H to K, for the position of cut-off to give unequal leads. Draw from J a tangent to the lead arc at A. Bisect the line JL by a diameter MN of the circle. Upon this diameter draw the two eccentric circles MO and NO. Draw the lap circles PQR and STU. The angle MOC

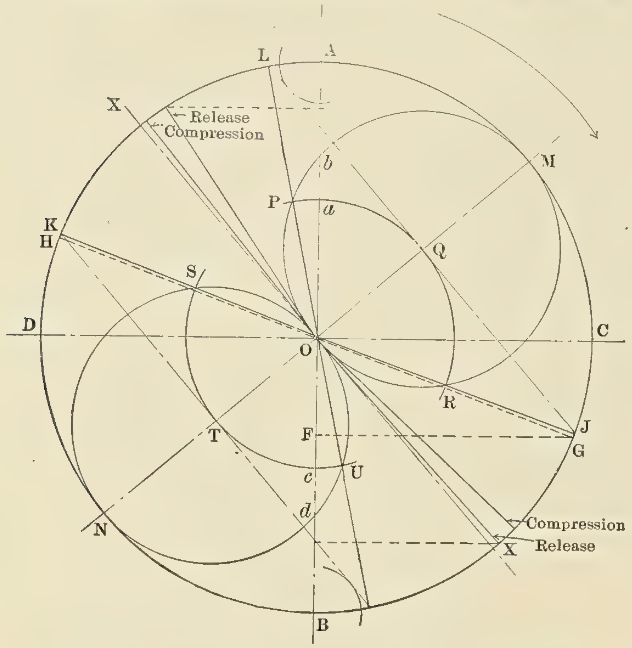


FIG. 45.

is the angle of advance, MQ is the maximum port opening at the top of the cylinder, and TN at the bottom. OQ is the steam lap for the top end of the valve, and OT for the bottom end.

No fixed rule can be given for finding the exhaust laps for the valve. Usually the release occurs from 7 to 15 percent before the end of the stroke, being earlier in fast running engines. The release upon the two ends can be made to occur at the same percent before the end of the stroke, but it is better to have the release upon the up stroke occur a little later than that upon the down stroke, as the dropping of the valve, due to wear, will cause it to occur gradually earlier upon the up stroke and later upon the down stroke. The compression due to this exhaust lap must be considered also, and if it occurs too early in the stroke, so that the engine would run badly, the release must be put earlier, to give a reasonable compression. This is especially important if the cut-off is somewhat short, in which case a rather large negative exhaust lap is required upon one end.

The best method of determining the amount of exhaust lap, and whether it is positive or negative, is to draw the line XX perpendicular to MN, and note the position of the release points relative to this line, which gives the position of the crank for the midposition of the valve. If the release on the down stroke occurs before the crank reaches XX, the exhaust lap is negative, if after the midposition it is positive.

The amount of lap will be the perpendicular distance between the release position and XX. Usually the exhaust lap upon the top is from —⅛ inch to —⅜ inch, and upon the bottom from ½ inch to —⅛ inch. There is no harm done if both laps are negative, thus permitting the two ends of the cylinder to be in communication at times, and no effect upon the indicator cards will be noticed until the sum of the exhaust lap amounts to about —½ inch. The distances ab and cd are also equal to the leads. It is well to tabulate the results, as shown later on in Table VIII.

If steam is taken at the middle rather than at the ends of the valve, the calculations are no different, the angle of advance of the eccentrics is increased by 180 degrees when they are placed upon the shafts, and the steam laps are placed nearer to the middle of the valve, instead of upon the ends.

The maximum port opening having been determined, and the width of port having been adjusted to give reasonable steam speeds, the final breadth of port in the case of the slide valve, or diameter of valve in the case of the piston valve, can be determined.

When piston valves are used, the high-pressure cylinder has one valve, the medium-pressure one or two, depending upon the size of the valves, and the low-pressure two or four valves. Two smaller valves are used in place of one valve when the one is more than half the diameter of the cylinder, or when the engine can be shortened materially by putting two smaller valves on either side of the center line, rather than one large one on the center line. When two valves are substituted for one, the diameter of each is half the diameter of the one for which they are substituted, as the steam is admitted around the circumference of the valves, and the circumference varies as the diameter.

The valves must be so located that their covers will not foul each other or the cylinder covers, and their location must also suit the crank shaft, in order that the ahead eccentric may be placed in the plane of the center line of the valve or valves. The distance between the center lines of the valves, when two valves are used for one cylinder, should be not less than $y = 1.6\ V + 1$ inch, nor more than $y = 1.8\ V + 2\frac{1}{2}$ inches, where $V =$ the diameter of the piston valves. The distance between the center line of the cylinder and the center line of the valves can be calculated, when the distance between valve centers has been selected, by letting this latter distance be one side of a right triangle, of which the hypotenuse is the sum of the radii of the cylinder cover and valve chest cover plus

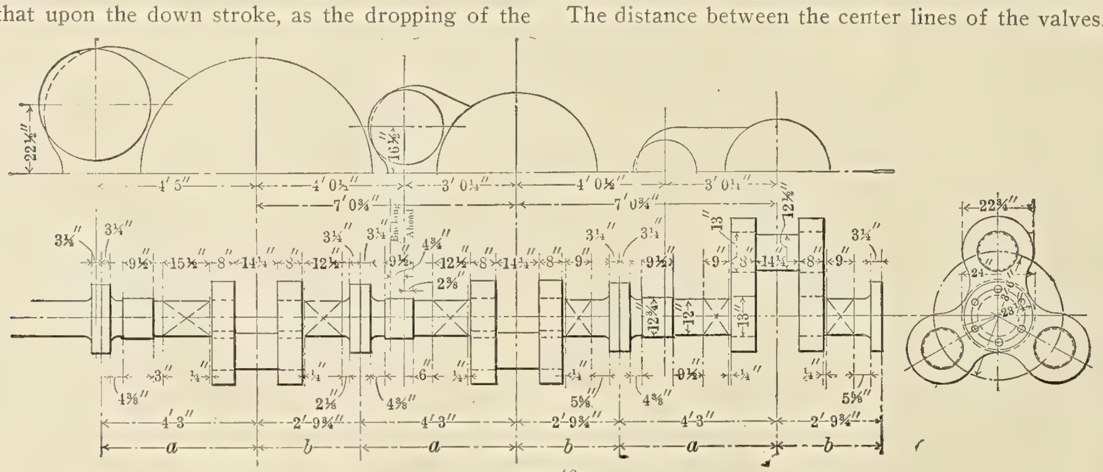


FIG. 46.

the desired clearance between the edges of the covers. This clearance varies from nothing to 6 inches, being determined sometimes by the arrangement of crank shaft.

$$X = \sqrt{\left(\frac{b}{2} + \frac{c}{2} + d\right)^2 - a^2}, \qquad (49)$$

where X = distance between center line of valves and cylinder, measured parallel to the center line of the engine;
b = diameter of cylinder cover;
c = diameter of valve chest cover;
d = clearance between covers;
and a = distance between center lines of valves.

The distance d should be sufficient to allow the steam passage between the barrel of the cylinder and the wall of the valve chest to be of the required area, without the passage being made too broad.

The accurate location of the center lines of the cylinders involves the finding of the diameters of the outside of cylinder covers and valve chest covers. Referring back to where the size of bolts used in the cylinder covers was determined, formula (18) gives the diameter of the inner surface of the barrel where the cylinder cover fits, and the diameter of the pitch circle of the bolts is taken as $C + 3d$, where C is the diameter referred to above, and d is the diameter of the studs used in the cover. The flange should extend beyond the pitch circle, an amount equal to $1\frac{1}{2}\ d$, so that the diameter of the outside of the cylinder cover should be:

$$E = D + 2L + 2J + 6d, \qquad (50)$$

where E = the diameter of the outside of the cylinder cover,
D = the diameter of the cylinder;
L = the thickness of the liner;
J = the thickness of the jacket space;
and d = the diameter of the cover stud.

The cover for the piston valve chest must be large enough to permit the liner to be put in. The diameter A having been determined by formula (48), and the thickness of the valve liner T being known, the diameter of the opening under the cover will be $A + 2T + \frac{1}{2}$ inch. The cover studs are usually 1 inch or $1\frac{1}{8}$ inches in diameter, with the same spacing as recommended for the cylinder cover studs, and the joint is usually $3d$ broad. The outside of the valve chest cover will then be:

$$F = A + 2 \times T + S \qquad (51)$$

where F = the outside diameter of the valve chest cover;
A = the diameter of the valve;
T = the thickness of the liner;
and S = $6\frac{1}{2}$ inches or $7\frac{1}{4}$ inches, depending upon whether 1-inch or $1\frac{1}{8}$-inch studs are used.

With these diameters, and the details and clearances of the shafting, a sketch like Fig. 46 can be made, locating the center lines of the cylinders and valves. The question as to whether or not the sections of the crank shaft are to be interchangeable must be decided before the distance between the center lines of the cylinders can be determined. If the sections are to be interchangeable, then the dimensions a and b (Fig. 46) must be the same on all sections, and the distances between the cylinder centers will be all the same, and equal to $a + b$. If the eccentrics for the low-pressure cylinder are to be on the low-pressure section of the crank shaft, then the minimum values of a and b will be determined by the low-pressure cylinder. If the eccentrics are to be on the thrust shaft or on the coupling, as shown in Fig. 46, then the minimum value of a will be determined by the medium-pressure cylinder, care being taken that a is not made so small that there is not room for the eccentric pad which must be provided for upon the

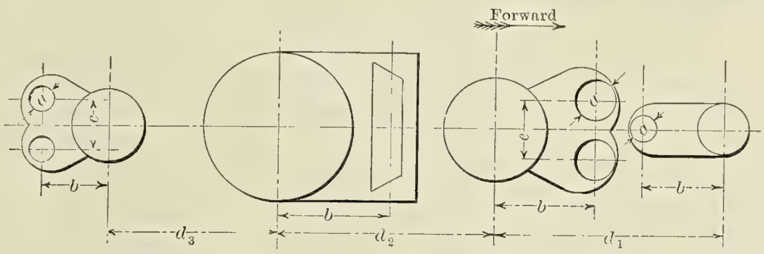


FIG. 47.—ARRANGEMENT KNOWN AS HAP-COD-LOS-MAD.

H—High-pressure cylinder.
M—First intermediate cylinder.
C—Second intermediate cylinder.
L—Low-pressure cylinder.
O—Valve is placed forward of cylinder.

A—Valve is placed aft of cylinder.
S—Cylinder has slide valve.
P—Cylinder has piston valve.
D—Cylinder has twin piston valves.
Y—Cylinder has four piston valves.

Number.	I. H. P.	R. P. M.	Boiler Pressure.	Cylinder Diameters.	Stroke.	Sequence of Cylinders, Type and Location of Valves.	First Cylinder. a.	First Cylinder. b.
41	600	220	200	8 –13¼–22	18	HOP–MOP–LOD...........	4¾″	14″
42	1,100	140	...	17 –25 –43	30	HOP–MOP–LOS............	8″	22″
43	1,500	80	175	22 –36 –59	42	HOP–MOP–LOS............	10″	2′ 6″
44	1,500	85	200	19 –31 –54	42	HAP–MOD–LOD...........	8″	2′ 5″
45	2,250	100	160	23½–39 –65	42	HOP–MOS–LOS............	10″	2′ 6⅞″
46	2,800	75	190	27 –44 –74	51	HOP–MOP–LAD...........	13″	2′ 11¾″
47	3,750	100	165	28 –46 –76	48	HAP–MOD–LOD...........	16″	3′ 0¾″
48	......	...	...	19–28½–41–60	42	HAP–MOD–LOD–COD.....	8″	2′ 8″
49	4,000	100	165	32–52–(2)60	42	HAP–MOD–LOD–LAD.....	18″	3′ 3¾″
50	......	100	215	23-33½-48½-70	51	HAP–MOD–COD–LOS......	15″	2′ 11″
51	5,000	85	170	32½–54 –89½	54	HAP–MOD–LOD...........	20″	3′ 9″
52	7,500	120	200	38½–59 –92	42	HAP–MOD–LY.............	16″	3′ 7″
53	8,000	86	200	35–50–70–100	66	HOP–LY–CAD–MAD........	20″	3′ 9″
54	10,000	85	175	42–66½–(2)77	60	HAP–MAD–LAD–LAD......	30″	4′ 10″

Number.	d_1.	Second Cylinder. a.	Second Cylinder. b.	Second Cylinder. c.	d_2.	Third Cylinder. a.	Third Cylinder. b.	Third Cylinder. c.	d_3.	Fourth Cylinder. a.	Fourth Cylinder. b.	Fourth Cylinder. c.
41	2′ 4½″	6¾″	15¼″	.....	2′ 11″	7½″	18¾″	13″	......	...	......	......
42	3′ 9½″	9½″	23¼″	.....	4′ 10″	....	2′ 10″	.....	......	...	......	......
43	6′ 4½″	17″	3′ 4″	.....	6′ 4½″	....	3′ 8″	.....	......	...	......	......
44	6′ 10″	8″	2′ 5″	17″	6′ 10″	16½″	4′ 1″	26″	......	...	......	......
45	5′ 7½″	....	3′ 0⅝″	.....	7′ 4½″	....	4′ 4″	.....	......	...	......	......
46	7′ 1″	25½″	3′ 9½″	.....	7′ 1″	25½″	4′ 7″	3′ 6″	......	...	......	......
47	8′ 0½″	18½″	3′ 2½″	2′ 6″	8′ 7″	33½″	4′ 11″	4′	......	...	......	......
48	7′	15″	2′ 9½″	.....	7′	19″	4′ 2″	2′ 4″	7′	12″	4′ 1⅝″	21″
49	....	18″	3′ 5″	2′ 6″	....	18″	3′ 8½″	2′ 6″	......	18″	3′ 8½″	2′ 6″
50	8′ 4″	15″	2′ 11″	2′ 6″	7′ 7″	23″	3′ 7″	3′	8′ 4″	...	4′ 9″	.....
51	10′ 2″	22″	3′ 9″	3′	10′ 2″	34″	5′ 11½″	4′ 6″	......	...	......	......
52	10′ 7″	20″	3′ 11″	3′ 1″	10′ 9″	20″	5′ 7″	2′ 8″	......	...	......	......
53	9′ 7″	25″	5′ 9¼″	5′	10′ 2″	28″	4′ 10¾″	4′ 6″	9′ 3″	17″	4′ 5″	2′ 9″
54	10′	30″	4′ 10″	4′ 9″	10′ 4″	36″	5′ 2″	5′	10′ 4″	36″	5′ 2″	5′

low-pressure section, even though it is not used for that cylinder. Sometimes all eccentrics are placed on the couplings.

When the crank shaft sections are not made interchangeable, the engine can generally be made shorter. A good arrangement of cylinders and valves is to have the medium-pressure and low-pressure valves grouped together between those two cylinders, and the high-pressure valves between the high-pressure and medium-pressure cylinders. This makes the piping very compact, although the over-all length of the engine may not be any less than with the other arrangement.

In a four-cylinder engine all of the sections are not usually interchangeable; but the first two sections are interchangeable, and so are the last two sections.

Fig. 47 gives arrangement data for several engines. Such a table is convenient for checking calculated results, and for estimating the distance between cylinder and valve center lines when there is not time for calculations.

It is very often convenient to know the length, breadth and height of an engine approximately. It will be found that the length of the engine over-all is from 1.8 ΣD to 1.9 ΣD, when the sections of shafting are not made interchangeable, and from 1.9 ΣD to 2 ΣD when the sections are interchangeable. ΣD is the sum of the cylinder diameters. The height of the engine from the bottom of the bed to the top of the covers is from 5 to 5¼ times the stroke for naval engines, and from 5½ to 6 times the stroke for merchant engines. The breadth of the bed varies considerably, but is almost twice the low-pressure diameter in merchant engines, and from 1½ to 2 times the low-pressure diameter in naval engines, depending upon the type of framing.

THE STEAMER COMMONWEALTH.*

BY WARREN T. BERRY AND J. HOWLAND GARDNER.

The *Commonwealth* was built for night service between New York and Fall River, a run of 180 statute miles, making one stop of about half an hour at Newport. The maximum designed speed is 22 statute miles per hour, although the established schedule requires a speed of only 18 statute miles, and with fair tide and wind 16 statute miles are all that are necessary. A speed of 20 or 22 miles is often required to minimize delays caused by head tides, high winds, delays at terminals and fog detention.

* Read before the Society of Naval Architects and Marine Engineers, New York, Nov. 20, 1908.

Inquiry was made as to the advisability of installing the Parsons type of turbine, but the economical results appeared to be rather experimental for speeds varying between 16 and 22 miles per hour. Experience with propeller and side-wheel steamers, in this particular service, demonstrates that very much greater overhang of guard can be fitted to the side-wheel boat. On the *Commonwealth* 19 feet 8 inches overhang, each side of hull, was necessary to provide for the spacious saloons and staterooms demanded by the traveling public. This extreme breadth of guard is in addition a very efficient

FIG. 1.—BROADSIDE VIEW OF THE FALL RIVER LINE STEAMER COMMONWEALTH.

safeguard against serious damage to the hull in case of collision. The compound inclined engine with feathering wheels, as adopted, combines the ability to stop and back very quickly, utilizes only lower hold space, which is of very little value for freight or passenger accommodation, and avoids the excessive vibration common to screw propellers in shallow-draft vessels.

The contract for building this steamer was made by the New England Navigation Company with the Quintard Iron Works Company on Oct. 12, 1906, the specified time of delivery July 1, 1908. The hull was launched at the yards of the William Cramp & Sons Ship & Engine Building Company Oct. 9, 1907, and the work of installing machinery and joiner work immediately commenced. The steamer was finally delivered, ready for service, with furniture and outfit complete, June 23, 1908. The general dimensions are as follows:

Length over all	455 feet 2 inches.
Length between perpendiculars	437 feet 11 inches.
Beam of hull molded	55 feet.
Beam over guards	94 feet 7 inches.
Molded depth, lowest point of sheer	22 feet.

TABLE OF WEIGHTS.

	Gross Tons.
Hull, ship carpenter work and steel construction	2,210
Joiner work	835
Steam engineering	1,760
Hull engineering	240
Coal	150
Water	40
Equipment, furniture and outfit	175
Total	5,410

Displacement, light (13 feet draft salt water), 5,410 gross tons.

Displacement, loaded (15 feet draft salt water), 6,410 gross tons.

The hull is built on the bracket plate and longitudinal system of the general scantling shown on midship section, Fig. 7. Seven watertight bulkheads extend to the main deck without doors or other openings, dividing the hull into eight watertight compartments above the double bottom. The double bottom extends for a length of 335 feet, and the margin plate is 5 feet above the base line. This double bottom is divided into forty-six watertight compartments.

To obtain quick handling in the harbors of Newport and New York, a rudder 14 feet 8 inches long, 12 feet 6 inches deep, is installed. This rudder is operated by a 26-inch diameter by 16-inch stroke Sickles type steering engine, located in the forward hold, connected by wire cables 1⅝ inches diameter to a circular steering head. This steering head is fastened to the rudder stock at the center and nigger-head at the aft end of the rudder, in order to distribute the stresses on the rudder and do away with the use of aft quarter blocks. The stock is utilized as a steadiment and for connection to a hand auxiliary gear of the diamond screw type, located on the saloon deck. A mechanical telegraph is fitted for communication from the pilot house, with direct reply from the rudder stock.

Two stockless anchors of 6,500 pounds each, with 180 fathoms of 2-inch stud link chain cable, are handled by a two-cylinder, 14-inch by 14-inch anchor windlass, with a capstan attachment on the saloon deck and two capstan heads on the main deck. For warping the steamer into dock two 12-inch by 14-inch steam capstans are located on the aft quarters.

The propelling machinery, designed for a maximum indicated horsepower of 10,000, is composed of a double compound, inclined, reciprocating engine with two high-pressure cylinders, 50 inches diameter and two low-pressure cylinders 96 inches diameter, with a common piston stroke of 114 inches, connected to two pairs of cranks set at right angles, shrunk on hollow forged steel shafts. The shaft is in three sections: two outboard or wheel shafts and one center shaft, all 27 inches diameter at the main journals and 30 inches diameter at the gunwale bearings. The crank pins are 22 inches diameter, shrunk in cranks on outboard shafts, but arranged

FIG. 2.—BOW VIEW OF THE NEW FALL RIVER LINE STEAMER COMMONWEALTH.

FIG. 3.—THE GENERAL ASSEMBLY ROOM, OR LOUNGE, ON THE COMMONWEALTH.

with loose brass chocks in the inboard cranks to provide for any change of alinement. All cylinders are fitted with double poppet valves, Sickles adjustable cut-off on the high-pressure cylinders, and Stevens fixed cut-off on the low-pressure cylinders, all operated with Stephenson links controlled by a 20-inch by 24-inch steam reversing engine. Two surface condensers of cylindrical type, each containing 8,000 square feet cooling surface, are located outboard of the low-pressure

FIG. 4.—THE DINING SALOON ON THE COMMONWEALTH.

cylinders, with suction pipes to two vertical air pumps 5 feet diameter by 30-inch stroke connected to the low-pressure crossheads. The engine frame is built of steel plates and angles in the form of box girders, so arranged that the main bearings are entirely within the frame.

The wheels are of the feathering type, of the following dimensions:

Diameter at center of trunnions......	26 feet 9 inches.
Diameter outside of buckets..........	31 feet.
Diameter outside outer rim..........	33 feet.
Number of arms....................	12
Width of buckets....................	5 feet.
Length of buckets..................	14 feet 6 inches.
Thickness of buckets................	1 inch.
Thickness of bucket reinforcing plates.	7/8 inch.
Curve of buckets....................	9 feet 6-inch radius.
Diameter of main pins...............	8¼ inches.
Diameter of rocker arm pins.........	6 inches.

The centers are of cast iron, the arms of wrought iron, to which are bolted cast steel trunnions, the buckets of marine steel with brackets and rocker arms of cast steel and pins of wrought iron cased with brass working in one piece lignum-vitæ bushings.

Steam is supplied by ten Scotch boilers, located five on each side, with center fire-room extending fore and aft. The boilers are 15 feet 6 inches in diameter by 13 feet 6 inches long, each having three Morison furnaces, 50 inches inside diameter, with a total grate surface of 937 square feet and a total heating surface of 29,340 square feet. Forced draft is supplied to closed ash pits by four blowers; two of these blowers are 7 feet in diameter by 32-inch face, driven by direct-connected engines, 7 inches diameter by 10½-inch stroke, and two blowers 8 feet in diameter by 38-inch face, driven by direct-connected engines, 10 inches diameter by 12-inch stroke. The discharge from two blowers located in the forward compartment is led over the main deck at the forward fire-room bulkhead, and the suction ducts for aft blowers lead from engine room over the main deck at the aft fire-room bulkhead, leaving the bulkheads watertight. Blower ducts are so arranged that they ventilate the engine room, boiler room and forward cabins as well as furnishing air for forced draft. A vertical fire-tube donkey boiler, 7 feet 2 inches diameter, 12 feet 5 inches high, is located on the main deck.

FIG. 5.—ONE OF THE BROAD STAIRWAYS IN THE MAIN HALL.

AN UPPER-DECK CORRIDOR.

The following pumps complete the engine installation:

Four centrifugal circulating pumps, 12-inch suctions.

Two boiler-feed pumps, outside packed plunger, duplex, 14 inches by 9 inches by 18 inches.

Two fire and sanitary pumps, also connected to boiler-feed lines. All brass water ends, duplex, 18½ inches by 12 inches by 12 inches.

One sprinkler pump. All brass water ends, duplex, 16 inches by 12 inches by 12 inches.

One bilge pump, duplex, 10 inches by 8½ inches by 12 inches.

One fresh water sanitary pump, duplex, 6 inches by 6 inches by 12 inches.

One donkey feed pump, single, 6 inches by 3¾ inches by 7 inches.

Two injectors for boiler feed.

Two 8-inch diameter by 15-inch stroke bilge pumps operated from main engine.

The electric outfit is comprised of two 75-kilowatt generators with 10½-inch by 18-inch by 8-inch engines, and one 50-kilowatt generator with engine 9½ inches by 15 inches by 6 inches, located in the engine room on the main deck, about 3,000 incandescent lights distributed throughout the vessel, a 24-inch searchlight on top of the pilot-house with pilot-house control, an electric elevator with a capacity of 2,000 pounds, running from the main deck to the store room and kitchen on the dome deck, and two electric blowers located in the after hold for the ventilation of the aft cabins. All wiring in the engine and boiler compartments, cargo space, emigrant quarters, crew quarters, kitchen and pantries, together with all outsire wiring, is in conduit with steam-tight fixtures, and all concealed wiring throughout the steamer is also run in conduit.

Particular attention has been paid to fire protection and fire-fighting appliances. All wood work throughout the cargo space, emigrant quarters, crew's quarters on the main deck, and kitchen on the dome deck, is covered with galvanized iron, fastened directly to the wood. Steel decks are fitted over the boiler compartment, coal bunkers and engine compartment. The engine room and boiler room ventilators and enclosures are of steel, extending through the top of the dome. Two fire bulkheads are provided, extending from the main deck through all decks to the dome, dividing the vessel into three fire compartments. These bulkheads are of double thickness ⅞-inch tongue and grooved wood, cross-planked diagonally and lined on both sides with Sackett plaster wall board covered with galvanized iron. Suitable sliding doors are provided in the main corridors and freight space. An iron bulkhead extending entirely across the upper deck house is fitted just forward of the kitchen range.

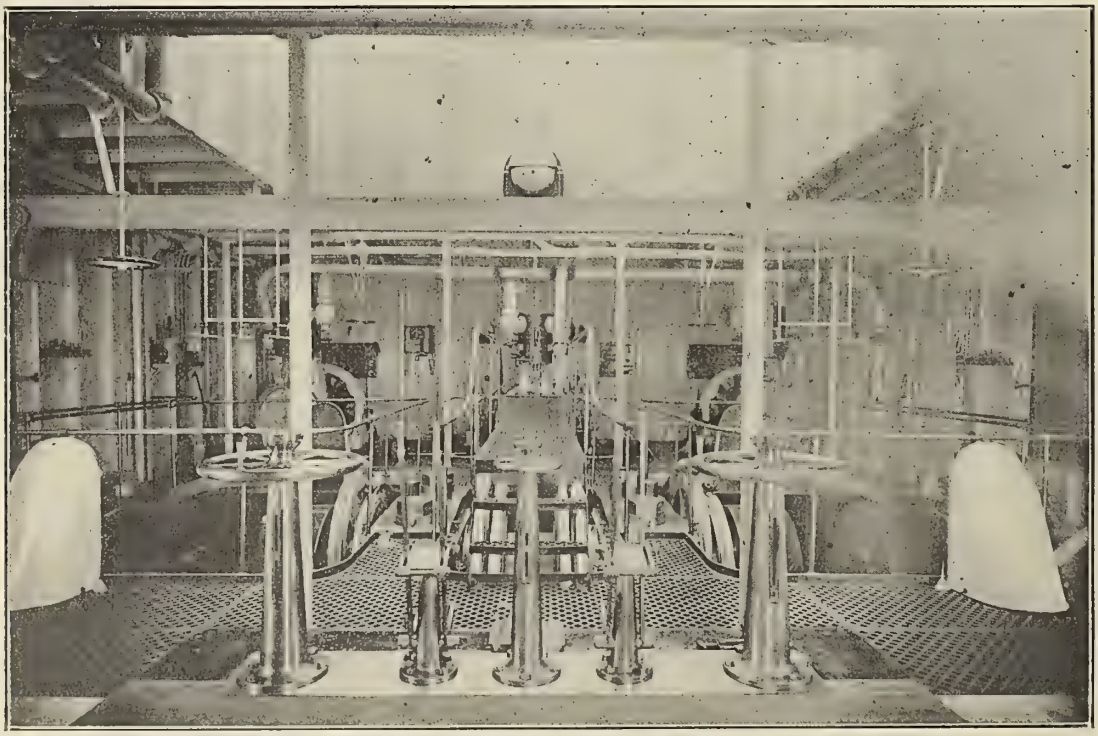


FIG. 6.—THE STARTING PLATFORM IN THE ENGINE ROOM OF THE COMMONWEALTH.

There are sixty fire hydrants located throughout the steamer, connected by copper fire mains with the fire and wrecking pumps, a 50-foot length of hose is coupled to each hydrant, and the location is such that all portions of the steamer are protected. Portable hose is also carried by both engine and deck departments, and thirty-seven fire extinguishers are located in convenient places.

In addition to this an independent sprinkler system is provided, with 1,800 automatic Grinnell heads distributed throughout the interior of the steamer, staterooms and lockers, not exceeding 8 feet from center to center in any place. This system is divided into thirty circuits, each with a 4-inch diameter main from a manifold located in the engine room on the main deck. To this manifold the main discharge from a 16-inch by 12-inch by 12-inch duplex sprinkler pump is connected. This pump at all times maintains a pressure at the manifold of 100 pounds per square inch, and is fitted with a governor to maintain this pressure in case of the opening of any of the circuits and sprinklers, and is also fitted with a throttle by-pass, which can be operated from the main engine room.

Supplementary to this system is a thermostat system with mercury thermostats, located not over 12 feet centers with all wires run in conduit, and divided into circuits corresponding with the sprinkler circuits. This system terminates at two annunciators, one in the main saloon and one in the engine room indicating the circuit number. The opening of a valve of corresponding number on the sprinkler system manifold supplies water to the sprinklers at the fire. In addition to the two main annunciators on the thermostat system, small annunciators are located throughout the saloons to determine the location of a fire within a range of a few staterooms. All the annunciator drops, besides showing the circuit number, indicate the location on the steamer, and ring 8-inch alarm bells located in the crew's quarters, engine room and saloons. This system deviates to some extent from the systems in use on land. The wet-pipe system, where all the pipes are filled with water under pressure, was impossible, because of the great weight and danger of freezing. The dry-pipe system

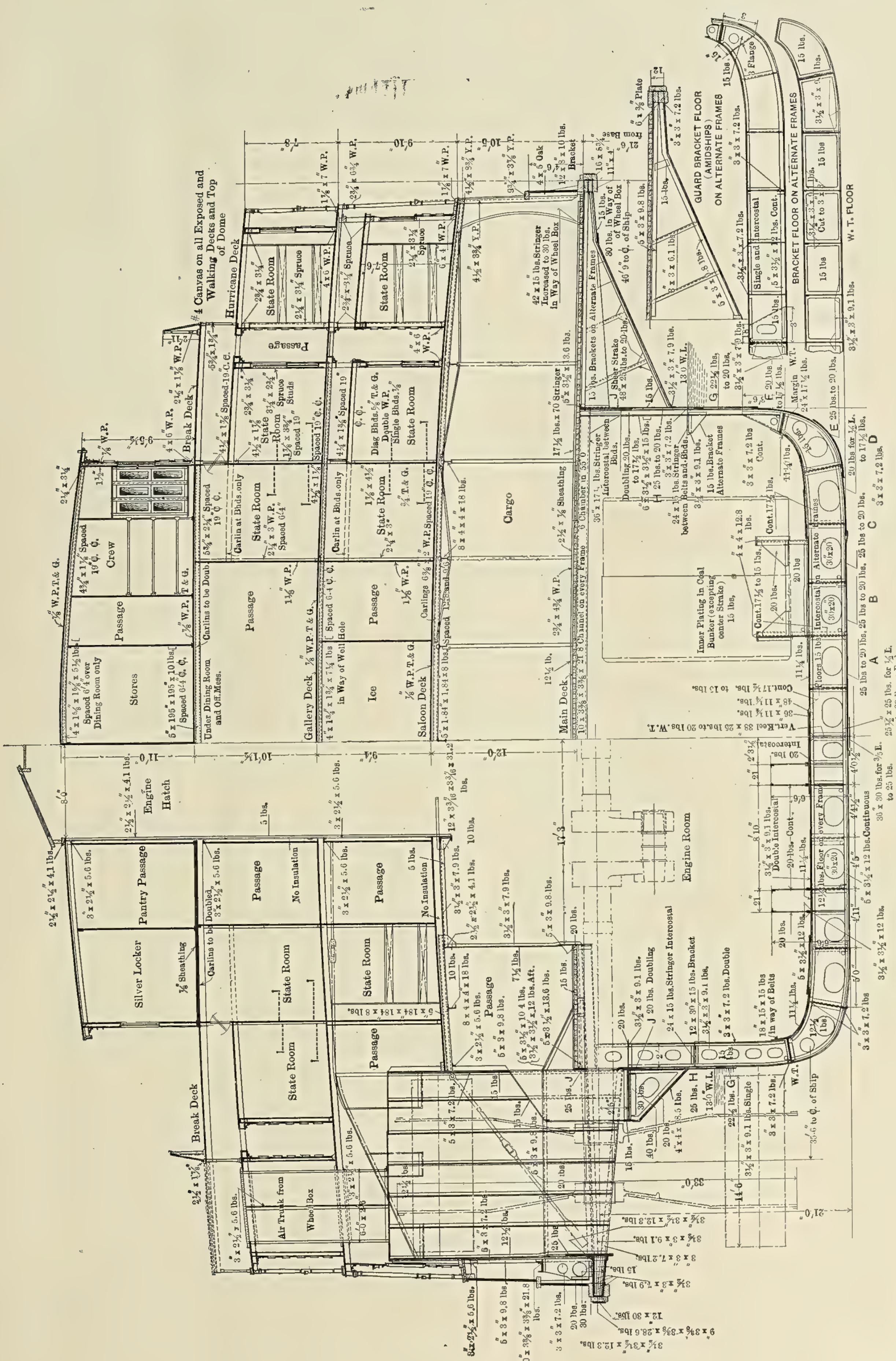


FIG. 7.—MIDSHIP SECTION AND SECTION THROUGH THE BOILER SPACE OF THE COMMONWEALTH.

with pipes filled with air under pressure which, when released, operates an automatic valve admitting water to the system, was not used because of the possibility of flooding a section of the ship where the pipes might be damaged in case of collision. A watchman's time detector is connected with thirty-eight recording stations, so located that in order to make a proper record, the watchman must pass through every section of the ship.

An 8-inch wrecking suction pipe is run fore and aft under the main deck. This is connected by 8-inch valves and suction lines to each compartment above the double bottom. The valves are so located in the compartments that they can be operated from the main deck. This system is connected to the two 18½-inch by 12-inch by 12-inch pumps on the main deck. The 10-inch by 8½-inch by 12-inch bilge pump, located in the engine compartment, has an independent suction line to each compartment above the double bottom and a connection to each of the forty-six watertight compartments in the double bottom. The four 12-inch circulating pumps are each fitted with 12-inch bilge suctions.

Twelve metallic lifeboats, ten 26 feet by 7 feet by 2 feet 9 inches deep, and two 26 feet by 6 feet 8 inches by 2 feet 9 inches deep; twelve life rafts, six 20 feet by 6 feet 8 inches, and six 18 feet by 6 feet 8 inches by 2 feet 3 inches deep; 2,250 block cork life preservers distributed throughout the staterooms, crew's quarters and saloons, and a Lyle gun complete the life-saving equipment.

A standard long-distance telephone is located in every stateroom and at various places throughout the saloons and crew's quarters, all intercommunicating through a switchboard. Independent telephones are fitted between the pilot-house and engine room and pilot-house and wireless telegraph room.

The location of the passenger toilet rooms between the engine and boiler enclosures, entirely away from ventilation through outside windows, as usually installed, utilizing a portion of the steamer that is undesirable for staterooms, is a departure which the result in use has justified. Large ventilators extend from the toilet rooms to the upper deck, one ventilator immediately back of the kitchen range and the other against the iron engine-room enclosure. The heat from the range and engine-room enclosure creates a draft through these ventilators, affording perfect ventilation. In addition suction pipes are connected to each urinal and toilet bowl extending to siphon hoods on the upper deck.

The officers' and crew's quarters are located mainly on the dome deck forward of the dining room and kitchen, though the deck hands and firemen are located below the main deck forward. On the dome deck is located the officers' mess room, seating forty-six, thirty officers' staterooms, with three water closets and two shower bath rooms for crew.

The kitchen and pantries are located between and around the boiler and engine enclosures on the dome deck. All wood work in the kitchen is lined entirely with galvanized iron and the floors covered with sheet lead and tile set in Sarco cement. The kitchen is fitted with a sectional range 21 feet 6 inches long, with six ovens and six fires, four broilers, each 2 feet 6 inches long, an electrically-driven dish-washing machine with electric hoist, two electric toasters, urns for tea, coffee and milk, and the usual hotel outfit of ice boxes, warming tables, bain marie, etc. The ice boxes, kitchen and pantries with silver and glass lockers, comprise about 2,400 square feet of deck space.

Because of the great weight involved, the butcher shop, with its ice boxes, is located on the main deck, convenient to the electric elevator.

A steam-heating system is provided of sufficient capacity to comfortably heat the vessel in the coldest weather, the main saloons, parlor staterooms and crew's quarters are fitted with standard radiators, while the regular passenger staterooms are heated with sill radiators divided into sections of about ten staterooms each, all arranged with independent cut-outs and to drain through traps to the main condensers.

The sanitary system provides fresh water under pressure to kitchen, pantries and bath rooms, and salt water to toilets, which are fitted with flushometers, porcelain bowls and ample drainage.

In general the decks above the main deck are of ⅞-inch tongue and grooved pine nailed to pine carlins of the scantling shown, all spaced 19-inch centers, stiffened by a steel structure comprised of channel beams, 12 feet 8-inch centers, riveted to 8-inch I-beam steel girders, extending fore and aft under stateroom bulkheads, supported by iron pipe stanchions riveted at top and bottom, or wood stanchions with ⅝-inch iron rods extending from deck to deck, rods spaced 12 feet 8-inch centers, and wherever possible these rods pass through and are nutted under the iron beams. All saloon deck girders are so situated that these rods pass through and are secured to the top flange. The bulkheads between staterooms are of tongue and grooved pine, alternately ⅞ inch single thickness and ⅝ inch double thickness, planked diagonally, nailed through with clinched nails. The double bulkheads are located at the iron carlins and fastened to them to obtain necessary athwartship rigidity.

The general arrangement of staterooms provides three rows of staterooms on each side of the saloon and gallery decks. The staterooms opening from the saloons are ventilated by concealed openings to the saloon and transoms opening over the upper deck of the adjoining outside rooms, the height of which is reduced for this purpose. The outer rows of staterooms have windows opening on the passageway and the outside of the deck house, respectively.

There are in all: eight staterooms for crew, containing 192 berths; forty-one staterooms for officers, containing 111 berths; 420 selling rooms for passengers, containing 826 berths; forty-five free berth rooms, containing 460 berths.

On the main deck forward are accommodations for thirty-six women and seventy-eight men emigrants. These quarters are fitted with galvanized iron pipe berths with canvas bottoms and hair mattresses. There are 300 spare mattresses for the use of passengers in the saloons, making a total of 2,003 mattresses.

The location of the dining room on the upper deck, with its attendant weight, necessitated a departure from the usual construction in steamers of this class. In order to support this weight, I-beam girders were run under this deck, and the entire structure supported by stanchions extending through the main saloon. In order to furnish a base for decorative treatment, double groined arches were fitted between these stanchions.

The lobby, or quarter deck, is treated in modern English, with oak and marquetrie panels. Adjoining the quarter deck are the purser's office, bar-room, barber shop, coat room and toilets. Aft is the library or social hall, finished in cream and gold, in the period of Louis XVI., and aft of this library is the woman's cabin, where are located the free berths for women passengers. From the quarter deck the main stairway leads up to a saloon finished in the period of Louis XV. Forward of this is the grand saloon with groined ceiling. This room has been treated in the Venetian-Gothic type of architecture, with decorated panels in all the arches and artistically painted lunettes at the sides. At the forward end is a large mural painting typifying the Commonwealth.

The passageways leading forward are of the period of Louis XVI. Opening off these passageways are toilet rooms, ice room, linen room, telephone and wireless telegraph rooms. Forward of this passage is the Empire saloon, which is finished in Honduras mahogany with gold ornamentations. From this saloon the forward staircase leads to the Louis XVI. saloon

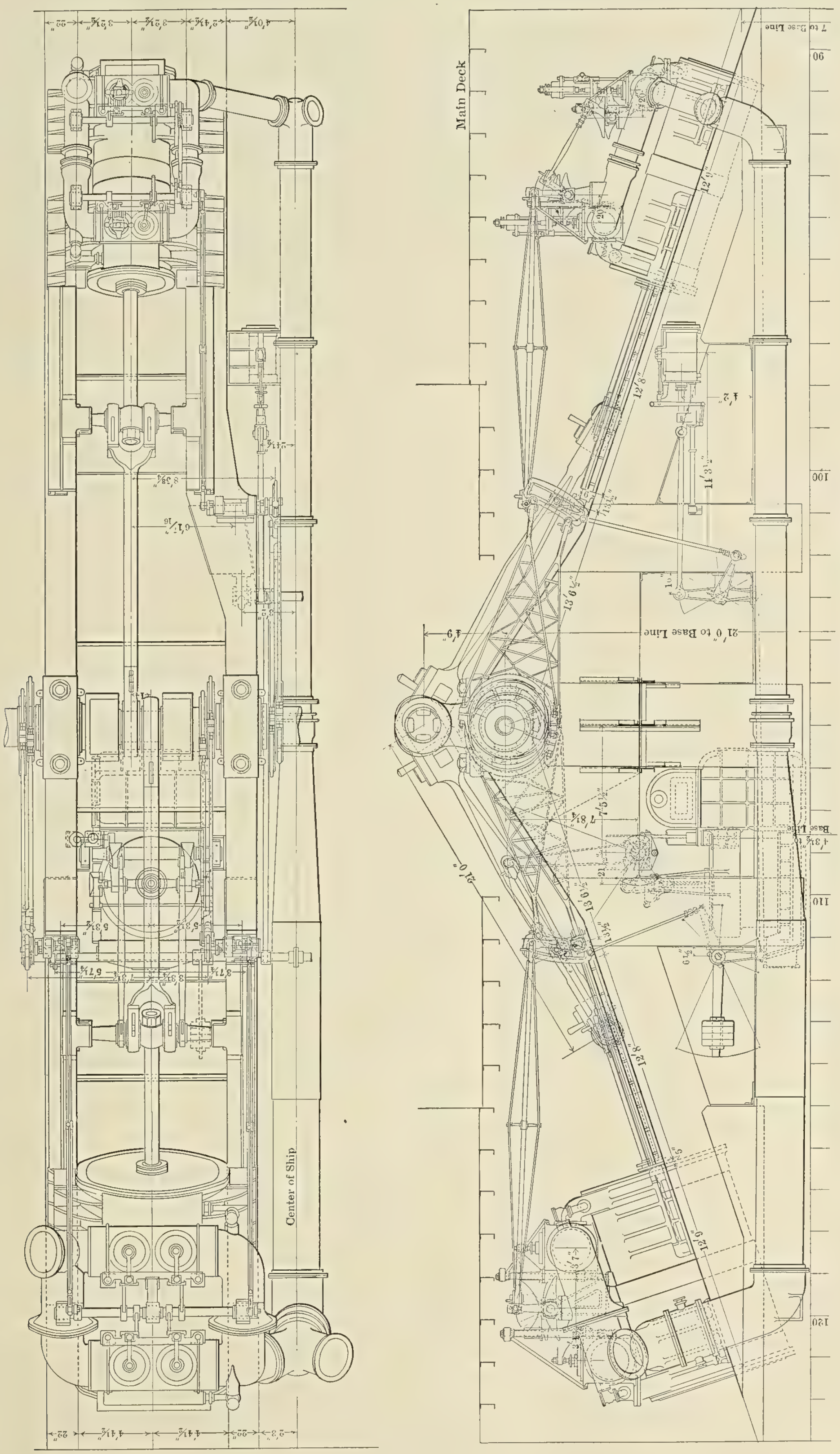


FIG. 8.—PLAN AND SIDE ELEVATION OF THE PORT ENGINES ON THE COMMONWEALTH.

on the forward gallery deck. This saloon, with the passageways leading aft alongside of the engine enclosure, are decorated in gray and white of the period of Louis XVI. Adjoining these passages are the gallery toilet rooms and a large writing room and newsstand. Aft of the gallery section of the Venetian-Gothic saloon is the Adams saloon, finished in primavera, with hand-painted panels and frieze. From the Adams saloon are stairways to the dining room and café on the dome deck. The café is finished in gray, open grain chestnut, in the period of the Italian Renaissance, and has a seating

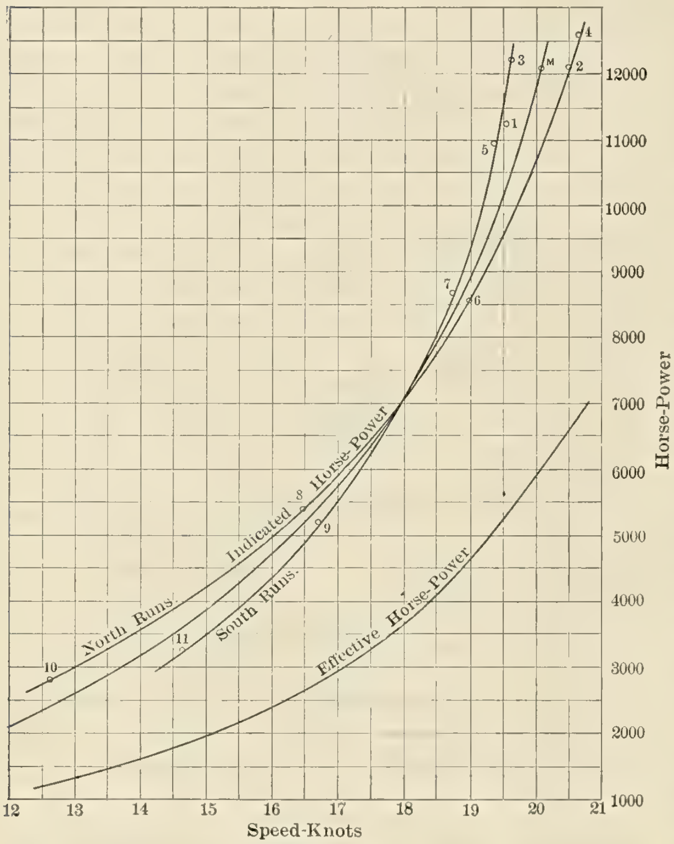


FIG. 9.—POWER AND SPEED CURVES FROM TRIALS OF THE COMMONWEALTH.

capacity of seventy-six. The floor is made watertight by covering the deck with canvas, painted, and then finished with interlocking rubber tiling. The tables and chairs are of polished oak, and the buffet bar at the forward end is of chestnut, to match the trim. The center of the room is lighted from a large dome with concealed lights.

The dining room has a seating capacity of 216, and is finished in gray and white in the period of Louis XVI. In the central portion of the ceiling are three domes, built of wire lath, covered with a special papier-mache plaster, the center one 24 feet 6 inches long and the two end domes 11 feet diameter. The center of the room is lighted from these domes by concealed lights. In addition each table is fitted with two-branch candelabra, and the sides of the room are lighted from bracket fixtures.

Off the Louis XV. and Adams saloon are located sixteen parlor bed rooms, four with bath rooms and two with shower bath rooms, fitted with the usual lavatories and toilet arrangements. These rooms are variously finished in the period of Louis XV. and Louis XVI.

In general, throughout the decorated portions of the steamer, all ceilings are made flush, the carlins being covered with composite board divided into suitable panels with decorated moldings. The groined arches of the Venetian-Gothic saloon are formed of narrow tongue grooved strips, covered with ¼-inch composite board, and finally the decoration applied on canvas. All the furniture, carpets, electric light fixtures and hangings are made in style to conform to the period of decoration of the saloon in which they are located.

Each stateroom is fitted with the usual two berths, bent wood stateroom chair and stool, mirror, electric light, glass and ice water pitcher rack. In the matter of washstands, however, a departure has been made in avoiding the use of wood. The lavatories are one-piece porcelain basins, fastened directly to the bulkhead, with waste into round porcelain slop jars supported by enameled iron brackets. Water is supplied from pitchers held in enameled iron racks. This arrangement of independent pitchers and slop jars was preferred to any fixed type on account of the facility with which they can be cleaned.

The *Commonwealth* has been in continuous service during the past summer, and has fulfilled all expectations of her owners, designers and builders.

PROGRESSIVE SPEED TRIALS.

The vessel was put into regular service immediately on completion, and on account of the large amount of travel she could not be spared for a trial trip until Nov. 14, at which time progressive speed trials were run over the Government course in Narragansett Bay, for the purpose of determining the indicated horsepower at various speeds and comparison with the data obtained from the model experiments at the Government tank at Washington. The model experiments were carried out on a draft corresponding to 13 feet mean, or 5,410 tons displacement salt water, trim 10 inches by the stern. The mean draft, during the trial on Nov. 14, determined by the observations before and after the runs, was 13 feet ½ inch, trim 12 inches by the stern, or 5,430 tons displacement.

The course is one knot long from marks on Jamestown Island, at the north end, to marks on Rose Island at the south end. The depth of water varies from 20 to 23 fathoms.

The steamer made her regular run from New York to Fall River, and after discharging passengers and freight, was taken down the bay to the course, where eleven runs were made, starting at about a quarter before eleven and ending at about half-past two. During the first runs the tide was flood, changing to ebb at about 12:45. Time over course, total revolutions of engine on the course, and steam pressures were recorded, and all cylinders indicated at the beginning and end of the run. These results were tabulated, and curves of speed and revolution, and speed and indicated horsepower plotted, and the mean curves drawn.

The first four runs were at 29.77 revolutions per minute; speed, 20.05 knots, or 23.09 statute miles per hour; indicated

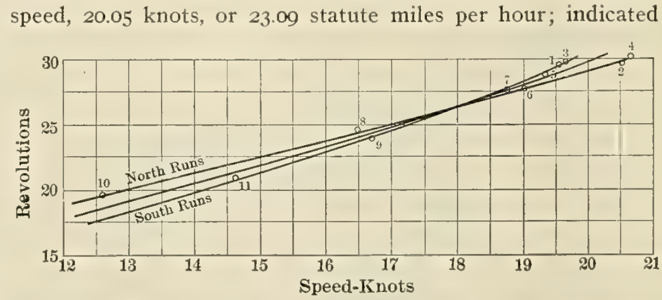


FIG. 10.—CURVES SHOWING RELATION BETWEEN SPEED AND REVOLUTIONS ON THE COMMONWEALTH.

horsepower 12,000. The corresponding effective horsepower from model tests was 5,950, which gives a propulsive coefficient of practically 50 percent. The apparent slip, figuring at the outside of buckets, was 29.92 percent, or practically 30 percent. It will be seen from the table that the propulsive coefficient varies between 50 and 52 percent, and the slip between 28 and 30 percent at the various speeds.

It is interesting to note the range of power which is necessary for the particular service in which this vessel runs. For a speed of 16 statute miles per hour, the corresponding indicated horsepower is 3,100; for a speed of 22 statute miles per hour, the corresponding indicated horsepower is 9,050.

This speed trial was conducted under the regular running conditions of the steamer, as to coal, crew, oil, etc. The coal was the regular buckwheat size of the same quality regularly supplied. No difficulty was experienced in maintaining a constant steam pressure during the full-speed runs. In fact, on the first run over the course the steam pressure increased 3 pounds. This is the greatest variation in steam pressure on any of the runs. All runs were made with the throttle wide open, and variations of speed were obtained by the adjustable cut-off on the high-pressure cylinders. It may be noted that the last two runs were made with a steam pressure of 126 pounds, as it was impossible to obtain the desired low revolutions on these runs with the adjustable cut-offs with full boiler pressure without throttling the engine.

STEAMER "COMMONWEALTH." PROGRESSIVE SPEED TRIAL DATA

Run.	Direction.	Time. Min. Sec.	Steam Pressure Engine Room Gage.	Average Revs. Per Min.	Average Revs. Per Min.	Speed Knots.	Speed Statute Miles.	App. Slip Outside of Buckets.	Indicated H. P.	Eff. H. P. From Model.	Prop. Coeff.
1	S.	3 4	145 / 148	29.51							
2	N.	2 55½	150 / 148	29.74							
3	S.	3 3	148 / 147	29.67	29.77	20.05	23.09	29.92%	12000	5950	50%
4	N.	2 54	148 / 147	30.17							
5	S.	3 5⁴/₅	147 / 147	28.62							
6	N.	3 9²/₅	150 / 148	27.56							
7	S.	3 12	152 / 152	27.50	27.53	18.90	21.76	28.56%	8625	4475	52%
8	N.	3 38²/₅	152 / 153	24.59							
9	S.	3 35½	152 / 152	23.97	24.28	16.65	19.17	28.64%	5350	2720	51%
10	N.	4 45³/₅	126 / 126	19.62							
11	S.	4 6	126 / 126	20.87	20.25	13.80	15.89	29.09%	3020	1520	50%
						19.10	22.		9050	4700	52%
						13.90	16.		3100	1570	50%

RECENT SCREW-PROPELLER DESIGN.

Around no one item in all the component parts of the propelling machinery of a ship has controversy raged so frequently, and for so prolonged a time, as it has around the determination of the most suitable proportions for screw propellers. Even the question of watertube boilers versus those of the cylindrical type has aroused less criticism and occasioned less prolonged discussion than the ever-present problem of propeller efficiency. In spite of the hundreds of vessels built each year and the enormous amount of data collected on the subject, we are still far from finality; but there is no doubt that in recent years very considerable progress has been made, and it is by no means correct to assume, as has so often been done, that we are still no nearer a solution of the difficulty of determining the best proportions. On the contrary, those who are more intimately engaged in the designing of high-speed vesels, and who have access to the elaborate records that can now be obtained by the use of torsion meters and the greater facilties provided by experimental tanks for research work, are coming to the conclusion that we are, after all, very much more nearly approaching the maximum efficiency that we can obtain from the screw as a propeller under the circumstances in which it is used, and, what is of more importance, are now able to predict much more easily the best dimensions for given conditions.

The investigation of the efficiency of the screw as a propeller in general, of the various forms and proportions of screws, and of the relative efficiencies of various numbers and arrangements, has received an enormous amount of attention, especially in recent years. The original investigations by the late William Froude have been continued by his son, and the experiments of the early eighties have recently been carefully checked at the Royal Naval Experimental Establishment at Haslar and found to be very accurate. Among the more elaborate series of trials of model propellers, as opposed those

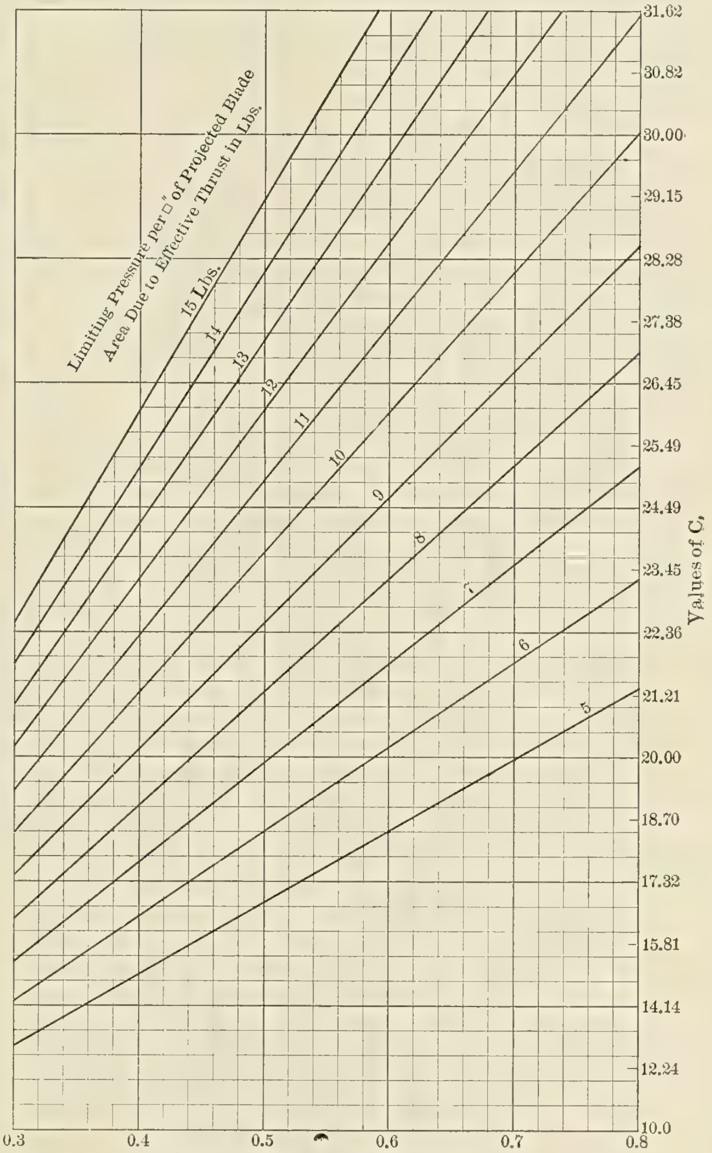


FIG. 1.—SPEAKMAN'S DIAGRAM FOR FINDING VALUES OF COEFFICIENT C.

on actual ships, we may mention the exhaustive series carried out by Messrs. Thornycroft, and published by Mr. S. W. Barnaby in his able book on screw propellers; the experimental investigations by the Hon. Charles Parsons on cavitation, which represented one of the most original scientific incursions into unknown phenomena of practical importance; the elaborate series of trials in the experimental tank at Washington by Naval Constructor D. W. Taylor, U. S. A., which were, with typical American generosity in scientific investigation, given to the world at the meetings of the American Society of Naval Architects; the recent experiments

on blade sections and on cavitation at the Imperial German Experimental Tank at Charlottenburg, and Mr. R. E. Froude's recent experiments at Haslar.

Among the most valuable series of trials of full-sized propellers on various ships, we have those carried out by Mr. Yarrow in 1879, which were published in the *Engineer;* also innumerable cases of trials on long voyages of the same or of sister ships fitted with various forms of screws; the remarkable trials in 1900-1903 of the *Good Hope* and *County* classes, and of the *Hyacinth,* with different forms and proportions of propellers; of the *Daring,* when the phenomenon of cavitation was first brought into prominence as of commercial importance; the trials of the *Turbinia* by Parsons, that corroborated the laboratory experiments above referred to; the trials of the German cruiser *Lubeck,* with numerous different numbers, sizes and proportions of propellers, and still more recently the trials of the British ocean-going destroyers of the *Tartar* class.

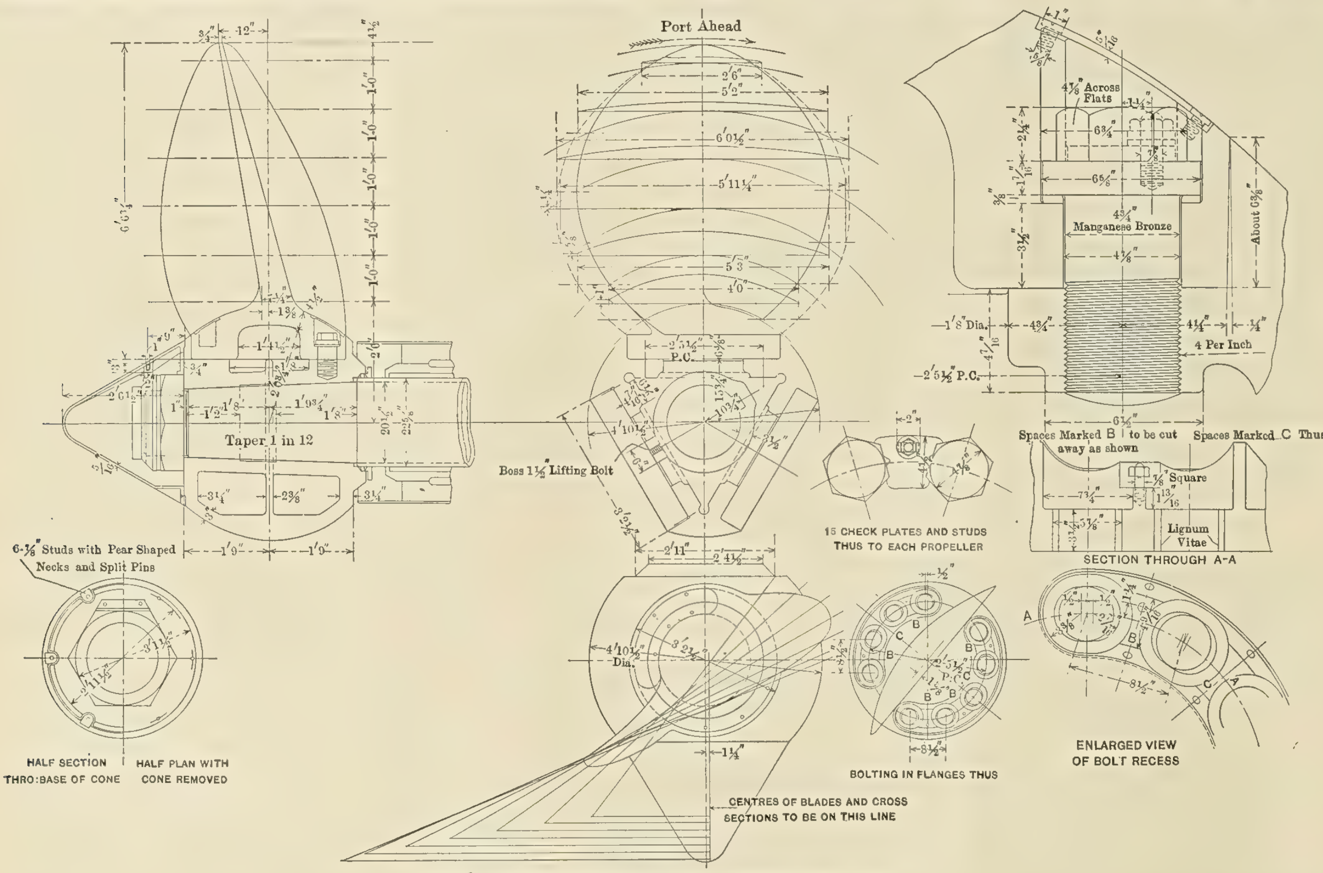


FIG. 2.—CRUISER PROPELLER WITH CONSIDERABLE RAKE.

The early history of screw propulsion demonstrates very clearly the groping into the unknown that was the inevitable burden of all the marine engineers of twenty years ago. That we have profited by the experimental nature of that work is as certain as it is that there are few who pause to contemplate the debt owed to former experimenters, and to render that tribute of thanks that they so thoroughly deserve.

While the power of steamships and the revolutions of the engines remained low, propellers were inevitably of enormous size in relation to the work to be done. As the revolutions have gradually increased, the propellers have decreased in size, till we are now at the extreme limit of reduced size, and are even inclined to go back to less exaggerated dimensions. An extreme comparison for 16-knot steamers might be made by comparing the *Great Eastern,* built in 1856, with another steamer built in 1906; the former had one screw 24 feet in diameter and 37 feet pitch, while the latter, of the same power and speed, has one propeller of 19 feet diameter.

But we are more particularly concerned with vessels of higher power and speed. Designers of such craft, especially of those of the destroyer type, are frequently faced by new phenomena that the constructors of slower and lower-powered vessels are not brought in contact with. Successful design is much more easy for the less arduous conditions, and our object is to emphasize those limiting features that are of such particular importance to builders confronted with new conditions.

For all practical purposes, reciprocating marine engines are obsolete for fast vessels, and it is hard to imagine any improvement that can reinstate them. Turbine machinery possesses such tremendous advantages that it is hardly worth while to consider the reciprocating engine propeller in these remarks. The turbine, whether of the Parsons or Curtis type, has to run at relatively high speeds; the screw propeller, from considerations of efficiency—*i. e.,* friction and slip reduced as far as possible—should not run too fast, and some compromise between the two is essential. In some of the old torpedo boat destroyers of ten years ago, various very important phenomena were brought to light in connection with screw propulsion. It was found that not only did the peripheral velocity of the blades through the water become undesirably high, but that under certain conditions the water was unable to follow the blades of the screw, and a cavity was formed between the back of the blade and the water, which, though undoubtedly reducing the water friction on the screw surface, had the simultaneous effect of permitting the screw to race badly, and the loss due to increased slip was excessive.

Mr. Barnaby, the naval architect to T. I. Thornycroft & Company, who first traced the matter to its source, published a very full description of his investigations, which were subsequently corroborated by Parsons. It was found that the blades of a propeller which obtain their reaction from the water by their action on the water, act in different ways on their two

faces. The after or driving face of a propeller exerts a push, and the forward side a pull upon the water. This pull is limited by the fact that the velocity that has to be imparted to the water in order for it to remain in contact with the blades at a depth h must not exceed $\sqrt{2\ g\ h}$ if the screw breaks the surface; but if it be sufficiently immersed to prevent air reaching it, the rate at which the water can be accelerated is much greater. Practical experiment showed that at a little depth below the surface of the water the tension exerted by the blade on the water could not exceed about 11 pounds per square inch without a cavity being formed, and that if the tension were increased the loss from slip increased very rapidly. Previous to the trials of the *Daring* and other destroyers of this period, the ratio of power to speed in torpedo craft had hardly ever been sufficient to cause this difficulty. Within wide limits this phenomenon of cavitation is unaffected by the diameter and pitch of the propeller. The important feature is projected blade area, because for a given thrust a given limit of tension per square inch can only be attained by adequate area. Mr. Barnaby gave an elaborate formula for this in his book on marine propellers, but based it on indicated horsepower and an assumed propulsive coefficient of 50 percent. Now, with turbine machinery it is impossible to calculate in terms of indicated horsepower, and effective horsepower alone can be considered.

The effective thrust along a shaft required for the propulsion of a given vessel is obtained from the formula $\frac{E.H.P. \times 33{,}000}{V \times 101.3}$, where V is the speed in knots. A simpler expression is $\frac{E.H.P. \times 326}{V}$. For a given limiting pressure of P pounds per square inch; the required projected area in square feet becomes $\frac{\text{thrust in pounds}}{P \times 144}$.

Mr. E. M. Speakman, now manager of the marine engineering department of Sir W. G. Armstrong Whitworth & Co., in a paper published in 1905, altered this formula so as to render it more rapidly applicable to purposes of design by including the ratio of projected surface to disk area, and converting the whole term into diameter in feet, so that a very simple expression is available. Mr. Speakman's diagram is given in Fig. 1; and provided the effective thrust is known—and this is an essential matter in turbine work—the coefficients given therein are extremely accurate. The formula in its most abbreviated form is:

$$\text{Diameter of propeller in feet} = \frac{\sqrt{\text{thrust in pounds}}}{C}$$

where C is a coefficient having values ranging from 20 to 30 for various classes of ships. A figure, however, of 24 to 27 ensures excellent results, provided the pitch ratio is between 0.9 and 1.05. The following table gives some up-to-date values for C; others may be found for earlier turbine vessels in Mr. Speakman's papers to the American Society of Naval Architects or the Institution of Engineers and Shipbuilders in Scotland:

TABLE SHOWING VALUE OF COEFFICIENT C.

Vessel	Speed	H. P.	Propeller Diameter	C.
H. M. S. Dreadnought	21:25	24,700*	8′ 10″	25.0
R. M. S. Lusitania	25.4	68,000*	17′ 0″	21.5
H. M. S. Tartar	35.6	21,000*	6′ 0″	29.5
U. S. S. Salem	26.0	21,000*	8′ 1½″	27.0
H. M. S. Good Hope (a)	23.05	31,500	19′ 0″†	17.5
H. M. S. Good Hope (b)	24.11	30,700	19′ 0″	18.5
R. M. S. Kaiser Wilhelm	23.3	42,000	23′ 9″	17.9

† Taken with the torsionmeter   † 30 percent greater area than (a)

With regard to the ratio of projected and disk area, a value of 0.5 to 0.6 seems to be most suitable for turbine work. In the *Daring* and the early destroyers it seldom exceeded 0.35, but has gradually increased. In the British ocean-going

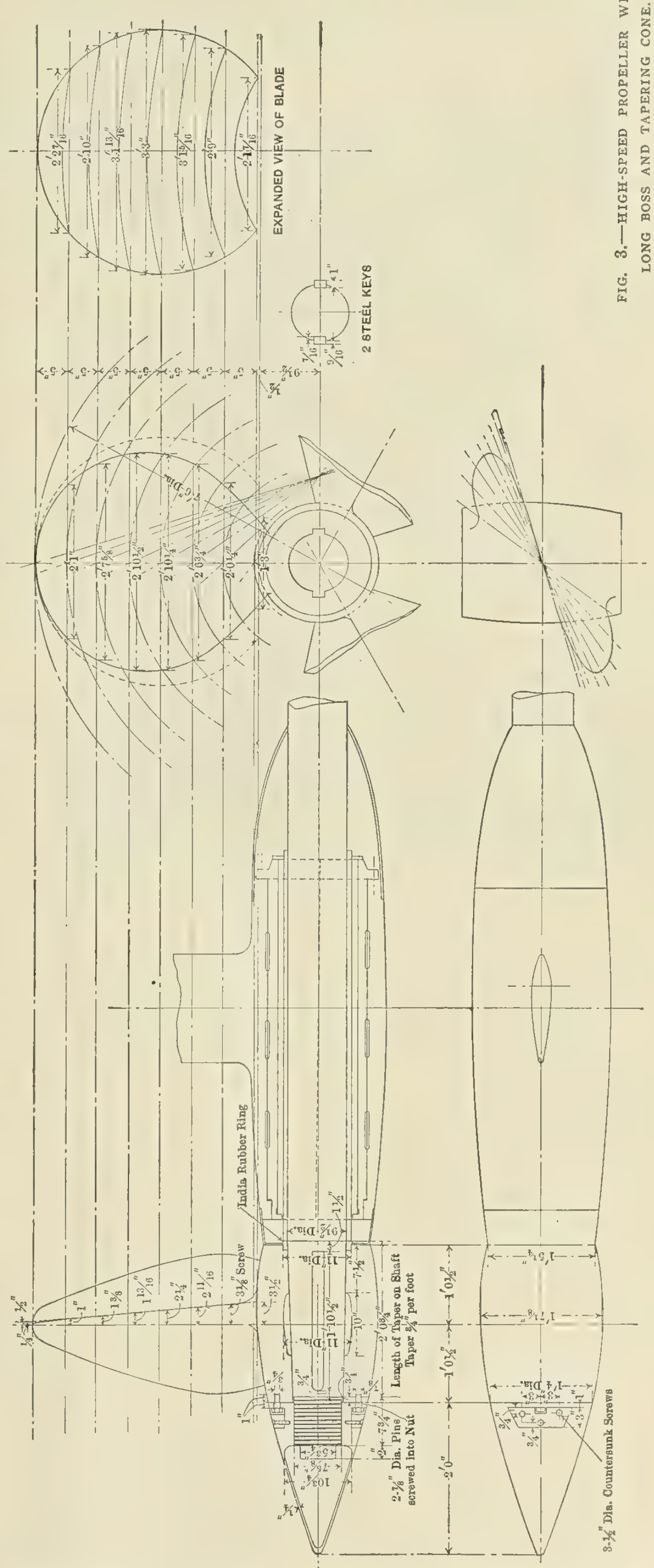


FIG. 3.—HIGH-SPEED PROPELLER WITH LONG BOSS AND TAPERING CONE.

vessels it was originally about 75 percent, but such a ratio was found to be excessive and more normal proportions were adopted. The good influence of rising from about 0.22 to 0.30 in the *Good Hope* is shown in the table; her early screws were deficient in area. The valuable experiments carried out

by Naval Constructor D. W. Taylor have added widely to our knowledge of propeller proportions. The effect of rake of the generating line of the blade was tested at the Washington tank by him, and found to affect the result only very slightly up to 10 degrees from the vertical either way. It is really hardly worth while raking propellers very much aft, and most turbine propellers are made with the generating line vertical. An example of a cruiser propeller with considerable rake is

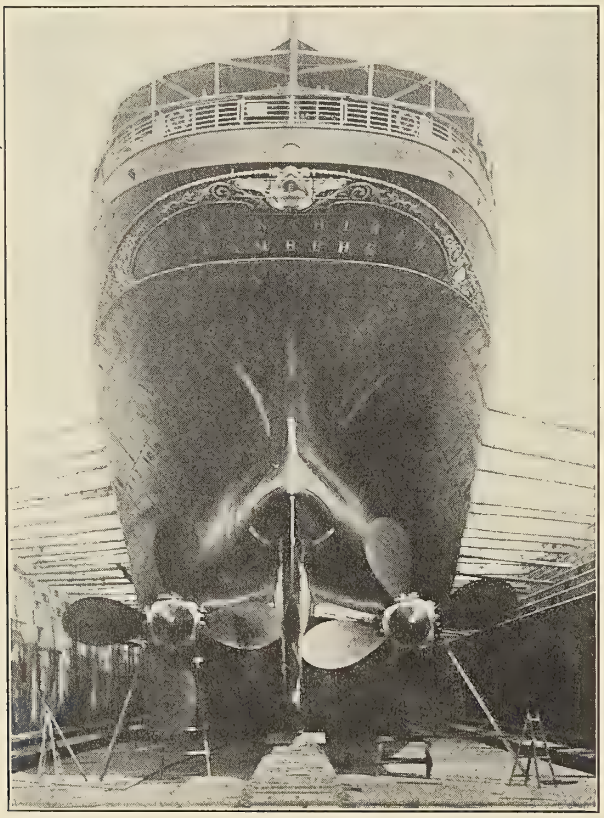


FIG. 4.—PROPELLERS OF THE DEUTSCHLAND.

shown in Fig. 2. Thickness of blade is of the greatest importance, and every effort should be made to reduce this to a minimum. Some difficulty will be found in doing so in turbine work in many cases, but the point should receive very careful attention.

The question of shape is an ever-interesting one. Experiments on both models and actual screws show that, provided the same area and thickness are maintained, shape alone has but little effect, and most turbine propellers are still made with circular blades in the projected view. An example is given in Fig. 3, where the long boss will be noticed as well as the tapering cone. This cone fulfills no idle purpose, as any student of the amazing cavitation photographs recently published by the Charlottenburg Tank Experimental Staff already knows. The high speed of rotation is apt to force the water clear away from the back of the boss, leaving an objectionable vacuous cavity that the cone is intended to fill or prevent. As will be seen in Fig. 2, little was done in this way some years ago, but every slight assistance is nowadays gladly accepted if any improvement in efficiency will result.

The question of the efficiency of modern screws is always interesting. That it has slightly fallen off with the introduction of the turbine was inevitable, but the over-all efficiency of propulsion is maintained at the same level by the more efficient engine. A figure of 70 percent has generally been regarded as the highest feasible for the screw propeller, and it is doubtful if this has ever been arrived at. Vessels like the *Kaiser Wilhelm* and *Deutschland,* whose propellers are shown in Fig. 4, have efficiencies of about 66 percent; those of the *Lusitania,* which will be much improved, were under 50 percent. The former figure is a very high one, as most naval propellers average 60 percent, and often less. Generally turbine screws exhibit efficiencies of between 50 and 55 percent. The exact determination of this efficiency rests on the accuracy with which we can determine both the brake horsepower and the effective horsepower. So little data is often available that inaccurate assumptions are frequently made, and the value of propeller efficiency, which is really very difficult to accurately determine, is only too often the subject of incorrect deduction or prejudiced assertion.

NOTES ON NAVAL SCIENCE TOPICS.

BY ARTHUR R. LIDDELL.

DECK CARGOES.

Closely connected with the question of stability is that of deck cargoes, which is now creating some attention in England and Germany.

The essential peculiarity of a vessel built to carry loads of timber on her deck is the variation in her effective depth—or perhaps height would here be the more appropriate term—which these bring about. Needless to say, a stack of timber on deck has buoyancy no less than a poop or a bridgehouse, and, provided it be thoroughly secured, it will have a righting moment of very considerable amount when the vessel lies over.

No vessel, of course, should be allowed to go to sea with a list, due to want or insufficiency of initial stability, but in practice a timber-carrier that is built for the trade, and has a large proportion of breadth to draft, will be safe against the danger of capsizing, with ever so small a *GM* height, even though she may have negative stability at angles of, say, 10 to 15 degrees.

It is well known that a high-sided vessel has a relatively wide range of stability, and this is the more true when the high side is made still higher amidships than at the ends. Beginning, it may be, with just enough initial stability to avoid taking a list, she then has a curve of righting levers which will, from angles of 15 to 20 degrees and onwards, steadily increase, up to very considerable inclinations (see Fig. 1).

The opposite case, of a vessel with deckloads or high erections at her ends, and a long gap in the middle of her length, will seldom come in question, though such cases are not altogether unknown. The curve of righting levers would in such case, perhaps, increase in height up to the point at which the gunwale becomes immersed, then diminish until it passes to the under side of the base line (becomes negative), and afterwards lie above the latter again at angles of about 45 to 90 degrees, somewhat as shown in Fig. 2.

It follows from the foregoing that a broad, low vessel, increased in height by a deckload for, say, three-fourths length amidships, will be fairly safe against capsizing as soon as she

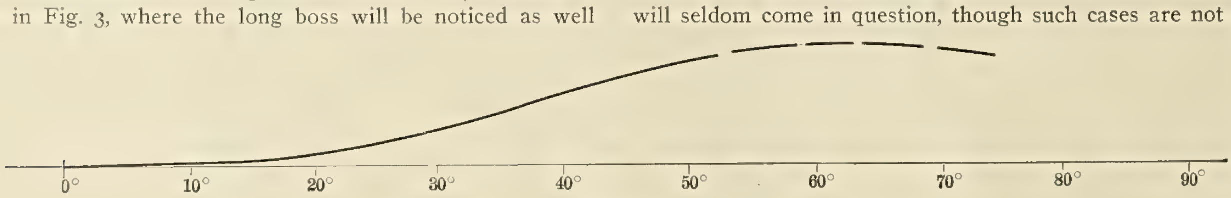


FIG. 1.

has so much stability that she can stand upright without taking a list; and, since the tendency of a vessel with small initial stability to roll is very slight, her seagoing qualities may be good.

Now, while a vessel with very little initial stability, that is, with a very small *GM* height, may be in good sea trim, it would not do for her to commence a voyage under such conditions. In the first place, her stability may become altered, during the passage, by the presence of water in her bilges or double bottom; and in the second place, the departure conditions may be very considerably altered by the burning out of her bunker coal, by the absorption of water by the timber on deck, or by the ice which might accumulate on the cargo during winter voyages.

It may be laid down as a rule that a vessel leaving port must have a *GM* height greater than the smallest admissible one by at least as much as such height can from any assumable cause be lowered during her voyage. The question as to what is the least admissible *GM* height must be answered according to the circumstances of each case. For a vessel of, say, 250 to 300 feet in length, with a high deck load of timber stowed amidships, it may be as small as about 6 inches—in practice it is sometimes still less.

It may here be urged that the captain of a vessel is not a trained naval architect, and that her *GM* height can be ascertained only by a resort to a heeling experiment, which, at the best, takes a considerable time to make, and which can yield reliable results only in the very best of weather. In reality, however, a captain who is accustomed to such cargoes can "feel" when a vessel is getting tender by her movements while the cargo is being put on board and trimmed. If he observe the effect, voyage after voyage, of the last crane-loads of timber deposited on the side of the stack, he will soon be able to judge whether the resulting inclinations are too great, and know when it is time to cease taking in cargo.

The objection to a high deckload is not the want of stability of the fabric, although this will somewhere set a limit not made good by unusually large stability at angles between 50 and 90 degrees.

In the assessment of freeboard for vessels with deck erections, it would be desirable that this circumstance should receive more consideration that has hitherto been given it. The points which, in the apportionment of freeboard, have hitherto received most attention have been height above the water of the platform on which the crew is to work, sufficiency of reserve buoyancy, and strength of the general structure. If we grant that stability be a quality which varies too much to admit of definite assessment, it might still be practicable to put certain limits to the proportions allowed to be borne by a vessel's dimensions, one to another, and to the distribution of the reserve buoyancy too much towards the ends of the vessel, as producing a state of things which will, under ordinary conditions of loading and stowage, make for danger.

If the issue by the state of further regulations for the loading of vessels be deprecated, it may still be desirable to establish rules for the guidance of naval architects and shipowners. The application of the equivalent block method described might here also be of advantage.

The metacenter and the center of gravity of the block being exactly determinable points, the amount of freeboard necessary to insure a given range of stability and given height of lever curve—for the block—are also fixtures, and the elaboration of tables for different relations of breadth, depth, freeboard, and fineness of vessel, one to another, which would sufficiently give the conditions likely to occur in practice, would be simply a matter of work. Such tables once made, it would be possible, for any proportions of depth to breadth, to pick out the freeboard corresponding with a desired average or extreme range of stability and height of lever curve. As has been shown under the head of stability, the conditions thus given for the equivalent rectangular block differ from those for the vessel by amounts not very great in themselves. These differences can, by competent authority, be approximated with tolerable exactness.

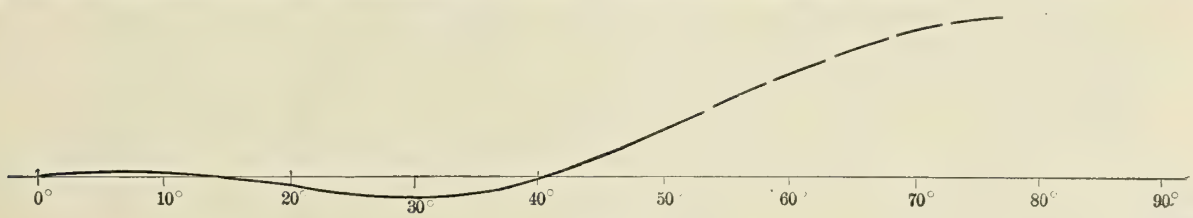


FIG. 2.

to the height. The danger is, that the timber may break adrift, or that it may be floated up from the deck when a sea breaks over the vessel, and, the lashings stretching somewhat, be deposited again slightly to one side of its old position, thus producing topsidedness. This tendency will show itself with every large wave which breaks on board, and the effect created by it will depend on the tautness and extensibility of the lashings.

Again, the extent to which the weight of the deckload may be increased by water soaking into or freezing into it is difficult to estimate. An ample margin of *GM* height should, especially during the winter months, be allowed for this.

What has been said above in regard to deckloads applies, in part, also to erections, such as inclosed poops, bridge houses and forecastles. A vessel with a bridge house extending over half her length is considerably better off as regards stability than one with a poop and a forecastle, each extending over a quarter of the length. Assuming the freeboard to have been reduced on the strength of such erections, the respective curves of levers of the vessel may in the former case show ample stability to angles of 50 or 60 degrees, and in the latter show a deficiency at angles of from 15 to 45 degrees, which is

THE AMERICAN SAILING SHIP.

BY CAPTAIN GEORGE L. NORTON.

From 1846 to 1860 was the most important period in the history of the merchant marine service of the United States; as it was during those years that her ocean-going tonnage reached its highest figure and gradually began its decline. It was during this fifteen-year period that the famous American clipper ships attained their world-wide eminence and began to drop out. This period is also memorable for the beginning of the short-lived American lines of transatlantic steamships, which opened with the promise of renewed and absolute mastery of the ocean-carrying trade and closed beneath the shadows of actual or impending defeat with the beginning of the Civil War. At the end of the war the American merchant marine in the foreign trade practically met its death blow; namely, the competition of foreign subsidized ships, built by cheap labor and operated by the same, causing American capital to look landward for investment, with the result that, while the United States now has the greatest and most efficient railroad service in all the world, her over-sea shipping has dwindled almost out of existence.

FIG. 1.—A FULL-RIGGED SHIP UNDER EASY SAIL NEARING PORT.

America's protected coastwise fleet of steam and sail vessels has increased in numbers, and the ships have grown in size, until it can now be said that, probably, no foreign fleet can be compared with these vessels in beauty of model, size, stanchness of construction and capacity to handle and carry cargoes of enormous proportions. As a consequence, these ships are always more or less prosperous. It is safe to predict, however, that the exclusion of American ships from the deep-sea trade is only for a time, and for a brief time at that, as no race with a grasp upon two oceans and the mingled blood of the Viking and pioneer can long be cheated of its birthright.

The illustrations herewith presented will give the eye of the admirer of sailing craft a treat seldom enjoyed in these days of continued illustrations of steam vessels. Sailing vessels are seldom considered, as they have become a non-paying investment in most foreign-going trades. A class of vessel, however, that has kept pace in growth with the coastwise and

FIG. 2.—SIX-MASTED SCHOONER "FULL AND BY."

FIG. 3.—BARKENTINE UNDER SAIL.

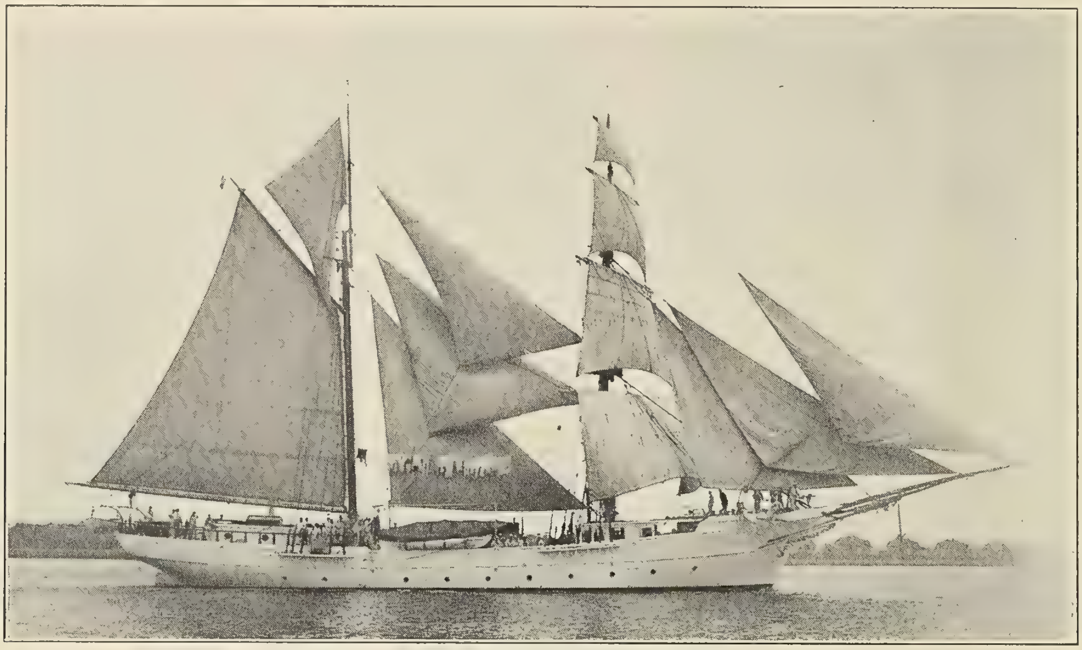


FIG. 4.—U. S. BRIGANTINE BOXER.

large fleet of steamers on the Great Lakes is the four, five and six-masted schooner. One seven-master, the *Thomas W. Lawson,* of 5,218 tons, was built in 1901. The *Lawson* was capable of carrying 8,000 tons of coal, but was a little too unwieldy at sea with her large number of heavy lower sails, and a misfit generally at the coal wharves and chutes in loading and discharging, besides being shut out of some ports where coal cargoes had to be landed in narrow rivers and above bridges. This vessel was lost nearly two years ago, and her loss has doubtless ended the career of seven-masted schooners. The four, five and six-masted schooners however, are ideal craft for 'longshore colliers; and as they are a style of craft that has come to stay in the coastwise trade, as well as in the ocean-going trade when business warrants, a brief history of the schooner from its beginning is of interest.

FIG. 5.—GLOUCESTER FISHING SCHOONER.

The first fore-and-aft, two-masted vessel was built at Gloucester, Mass., by one Captain Andrew Robinson, and it is said that its name was derived from the fact that a bystander at the launch, as she struck the water, exclaimed: "See how she scoons!" "If she scoons," remarked her builder, "she must be a schooner"—hence the name. The first three-masted schooner, the *Zachary Taylor,* was built in 1849, in Philadelphia. Her mizzenmast was shorter than her fore and main masts, the only noticeable difference in rig between then and now. She was of 250 tons gross and her first voyage, which was to Aspinwall and return, was a success. The *W. L. White* was the first four-masted schooner, and was built at Bath, Me., in 1880, by Goss, Sawyer & Packard, on the site of what is now the plant of the New England Shipbuilding Company. This vessel was of 995 tons gross. The *Governor Ames* was the first five-masted schooner and was built at Waldoboro, Me., in 1888; and although she has been dismasted twice, she is still in service. She is 1,778 tons gross. Camden, Me., produced the first six-masted schooner; namely, the *George W. Wells,* of 2,970 tons gross, in 1900. Since that time there has been quite a number of this class of vessels built. On Nov. 10, 1908, there was launched from the yards of Percy & Small, at Bath, Me., a monster five-masted schooner of 2,989 tons gross. When launched, this vessel could have proceeded to sea at once, as she had her sails bent and crew and stores on board, a degree of completion at launching not uncommon in this the greatest of wooden shipbuilding ports of the United States, and from which have been launched some of the best-known sailing vessels maritime nations have ever seen.

Reports from the Commissioner of Navigation in 1906 show that up to that time four calendar years had elapsed since a square-rigged vessel was built in the United States. Two years previous to that date the prediction was made that at the present rate of decrease, the remaining square-rigged fleet would totally disappear in less than twenty years. Since then, up to the latter part of 1906, there has been a decline of 14 percent in number and 11 percent in tonnage of these vessels, so that at the beginning of the year 1906 this fleet numbered only 276 vessels of 322,288 gross tons. In the years preceding 1890, when conditions began to render the operation of square-rigged vessels unprofitable, many of these were dismantled and converted into barges. This practice has con-

tinued, although since 1890 a large number of wooden and steel barges have been especially constructed for carrying coal, oil and other bulk cargo.

Bureau Veritas reports for 1908 show that the total net tonnage of sailing ships in the world, including only ships of 50 tons net and upwards, is 6,993,730 tons, of which 1,408,513 tons, or 20.15 percent of the whole, is credited to the United States. The aggregate tonnage of United States sailing ships is exceeded only by that of English ships, which amounts to 22.75 percent of the whole, and it is more than twice as large as that of any other country.

While the total gross tonnage of United States shipping has increased 54.2 percent during the seventeen years from 1889 to 1906, this has been due, largely, to the increase in tonnage of steam vessels and unrigged craft; for the tonnage of sailing vessels has increased only 1.7 percent during this period, while the total number of sailing vessels has decreased 10.2 percent. Of the total number of sailing vessels

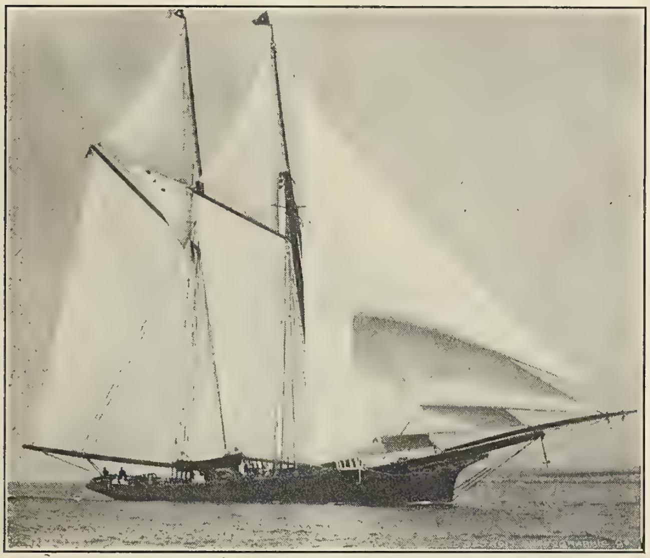


FIG. 6.—DAUNTLESS—TYPICAL AMERICAN YACHT OF THE SEVENTIES.

classed by the American Bureau of Navigation in 1906, 5,181, or 72.7 percent, are engaged in freight and passenger trade. These represent 98.2 percent of the gross tonnage, and 91.5 percent of the total value of sailing ships in the United States. The remainder includes yachts and small craft. The tonnage of these merchant sailing vessels is distributed as follows: 66.5 percent on the Atlantic Coast and Gulf of Mexico; 17.9 percent on the Pacific Coast, and 15.6 percent on the Great Lakes and St. Lawrence River. During the seventeen-year period from 1889 to 1906, the tonnage of sailing ships on the Atlantic Coast and Gulf of Mexico decreased 12.4 percent, while that on the Pacific Coast increased 56.1 percent, and that on the Great Lakes and St. Lawrence River increased 43.5 percent.

While it is a source of great regret that the American ship in the over-sea trade is practically a relic of the past, the American people can get some consolation by referring back to the historians before the Civil War, where we find that American ships were in the first rank, and certainly the equal of those of other shipbuilding and shipowning countries, and that the men who commanded them were the peers in ability, learning and standing of other maritime nations. Lindsay, the historian of the British merchant marine, who had been a sailor as well as shipowner, says in his authoritative work, "During the first half of this century, the masters of American vessels were, as a rule, greatly superior to those who held similar positions in English ships, arising in some measure from the limited education of the latter, which was not sufficient to qualify them for the higher grades of the merchant service. American shipowners required their masters to have not merely a knowledge of navigation and seamanship, but also of commercial pursuits, the nature of exchange, the art of correspondence, and a sufficient knowledge of business to qualify them to represent the interests of their employers to advantage with merchants abroad. On all such matters the commanders of English ships, with the exception of the East India Company, were at this period greatly inferior to the commanders of United States vessels."

A committee of the House of Commons, in 1836, had spoken of the "vast superiority in officers, crews and equipment, and the consequent superior success and growth of American shipping." The British Consul for Maine and New Hampshire, in a report to the Foreign Office, in 1847, said: "Education is much prized by the citizens; many vessels, therefore, are commanded by gentlemen with a college education and by those educated in high schools, who, on leaving these institutions, enter a merchant's counting room for a limited time before they go to sea for practical seamanship, etc., or are intrusted by their parents, guardians or friends with the command of vessels."

Such was the acknowledged superiority of the American merchant officers at the time when Great Britain began to overwhelm her sailing fleet with mail subsidies, which were in large part virtually bonuses upon the steamship and iron shipbuilding industry. If subsidy had been met with subsidy, and this protectionism been adhered to as tenaciously as Britain did, and the same encouragement had been offered to iron shipyards that was given to cotton mills and the iron industry in general by high duties after 1860, the splendid officers and seamen of the American merchant marine would have won the fight, in spite of the temporary havoc wrought among United States sailing vessels by the Civil War. Great Britain stood loyally by her shipowners, and with constant and unceasing subsidy protection tided them over their years of trial and misfortune. The United States deserted her shipowners in their time of need, leaving them to fight single-handed the hazards of the sea, the vicissitudes of the unfamiliar trade of steam navigation and the treasuries of foreign governments. Who can wonder that they were beaten in this unequal contest, and driven from the sea?

Ventilation by Induced Currents.

At the Institute of Marine Engineers, on Dec. 5, a paper on "Ventilation by Induced Currents" was read by Mr. Robt. Gregory. The system described by Mr. Gregory consisted of a nozzle placed in a series of corrugated tubes of different sizes telescoped into one another, and so arranged that at each diminishing diameter an annular space remained between the tubes of sufficient area for the vitiated air to flow in at the junctions, thus carrying off the foul air or gases. The nozzle was fitted into the smallest tube, and was connected to an accumulator or reservoir of compressed air, supplied by a small air compressor. Pipes, fitted with a regulating valve, could be carried from the accumulator to each compartment or hold, and there connected to their respective ventilators, which could be used either as downcasts for fresh air or as upcasts for exhausting the foul air. Instead of compressed air a centrifugal fan could be used for supplying air to the nozzles, and by means of hot air chambers the air could be heated for the purpose of warming the cabins or saloons.

THE NEW TWIN-SCREW MAIL STEAMER MOREA.

Designed for fast mail and passenger service to India and Australia, the new twin-screw steamer *Morea,* which has just been completed by Barclay, Curle & Co., Ltd., at their Clydeholm shipyard near Glasgow, comprises the most recent addition to the large fleet of the Peninsular & Oriental Steam Navigation Company, Ltd. The keel of the vessel was laid Nov. 6, 1907, and she was launched Aug. 15, 1908, or within a period of nine months and one week. Three months more were required for fitting her out, and she was taken out for her official trial trips on Nov. 5, 1908, or exactly twelve months after construction was begun.

The principal dimensions of the vessel are:

Length	560 feet 0 inches
Breadth	61 feet 6 inches
Depth	39 feet 0 inches
Gross tonnage	11,500
Designed speed	18 knots
Number of first class passengers	407
Number of second class passengers	200

The *Morea* was built under the supervision of the Peninsular & Oriental Company's own staff of inspectors, to the requirements of the Board of Trade for a foreign-going passenger steamship, and under special survey of Lloyd's.

The hull is of Siemens-Martin mild open-hearth steel, the scantlings being considerably in excess of the requirements of Lloyds. It is divided into separate watertight compartments in order to provide for safety, a complete inner bottom being fitted all fore and aft with numerous watertight bulkheads dividing the hull transversely. There are four complete decks—viz: orlop, lower, main and upper—sheathed with teak and yellow pine. Above the spar deck, at the fore end, is a long forecastle, amidships the hurricane deck, and at the after end the poop deck. Above the hurricane deck is the first class promenade deck, extending for 300 feet amidships. The second class promenade deck, 180 feet long, is situated above the poop deck. Above the midships promenade deck is the boat deck, at the fore end of which are the captain's and officers' rooms, surmounted by a wheelhouse and two flying bridges.

The arrangements for passenger accommodations have been designed to give the maximum space and comfort to each individual. The first class passengers are all berthed amidships; the sleeping cabins being placed on the main, spar, hurricane and promenade decks. The general practice of placing a number of cabins on the promenade deck has been adhered to. The dining saloon, a large and spacious apartment, is situated on the spar deck at the fore end of the bridge space and extends the full breadth of the ship. A feature of this apartment is its great height and the large open well overhead, which extends through three decks to a large dome of stained glass on the boat deck. Electric bells, fans and lights are provided here as elsewhere throughout the vessel. A handsome double stairway at the after end of the dining saloon leads to the hurricane deck entrance hall, aft and forward of which are placed the divan and music rooms. At the after end of the promenade deck is situated the first class smokeroom, a spacious and well-appointed room, with a large lighting well overhead. The paneling of all the public rooms is of fumed oak, with fibrous plaster ceilings, the whole of the decoration being carried out by the builders to designs supplied by Messrs. Collcutt & Hamp, of London. The sanitary accommodations are fitted up in numerous small blocks each complete in itself, placed at different points throughout the passenger accommodations, so as to make them readily accessible. Baths with hot and cold water, hot and cold showers, hand wash basins, and all other necessaries are provided in numbers in excess of the usual complement.

The second class passengers are accommodated towards the after end of the vessel, and everything is provided for them on a scale and in a style only inferior to the first class; the dining-room, smoking room, entrance hall and sanitary accommodations being all arranged with the same care and attention as the first class.

THE NEW P. & O. MAIL STEAMER MOREA.

The stewards' department, one of the most important on a passenger steamer, has received due attention. Large store rooms are provided on the orlop deck, together with a refrigerating chamber with separate compartments for preserving perishable provisions; also an ice-making room, the temperature of these chambers being kept at any desired point by a refrigerating machine on the dry-air principle, placed in engine room. In addition to this, a large refrigerating installation is fitted for the purpose of carrying meat cargoes in the forward holds, which are insulated for the purpose.

The galleys are placed on the spar deck and are fitted up with all the usual appliances. Adjacent are the bakers' shop, with dough-mixing machines, dish-washing machines, etc., butchers' shop, scullery, vegetable room, etc. Large pantries are fitted, adjoining each dining saloon, with hot and cold water and carving tables heated with steam.

On the spar deck, at the after end, is situated a large post office replete with sorting tables and every other device necessary for the expeditious handling of mails, while on the main deck is a supplementary sorting room, so that a more than ordinarily heavy mail may be handled. The mail rooms for India, China and Australian mails are situated on the lower deck.

The Lascar crew are berthed at the extreme after end, under the poop, while the British crew and stewards are accommodated forward on the lower, main and spar decks. The engineers are on the spar deck, alongside the entrance to the engine room.

A large chart room and wheelhouse is provided, containing the steering wheels and other navigating appliances, including Kelvin compasses, engine-room telegraphs, docking and steering telegraphs, speaking tubes, and loud-speaking telephones to the engine room, forecastlehead and after end of the vessel. The steam-steering gear is in a steel house immediately over the rudderhead, actuated by telemotor gear from the bridge, and aft a hand gear is fitted for emergencies.

The propelling machinery consists of two sets of four-crank, quadruple-expansion engines balanced for smooth and silent working. On her trial trip the engines developed sufficient power to give the vessel a speed of over eighteen knots.

Steam is supplied by eight boilers working at a pressure of 215 pounds per square inch, four of which are double-ended and four single-ended. Collectively, there are thirty-six furnaces, all supplied with Howden's system of forced draft, operated by four large electrically-driven fans. All of the piping is covered with a patent insulating covering, supplied by Messrs. Matthew, Keenan & Co., Ltd.

The outfit of auxiliary machinery in the engine room is unusually comprehensive, and includes fourteen separate steam pumps, an ash expeller whereby the ashes are forced out through the bottom of the ship, and a feed-water evaporator and filtering plant is fitted both in the engine room and in conjunction with the refrigerating machinery.

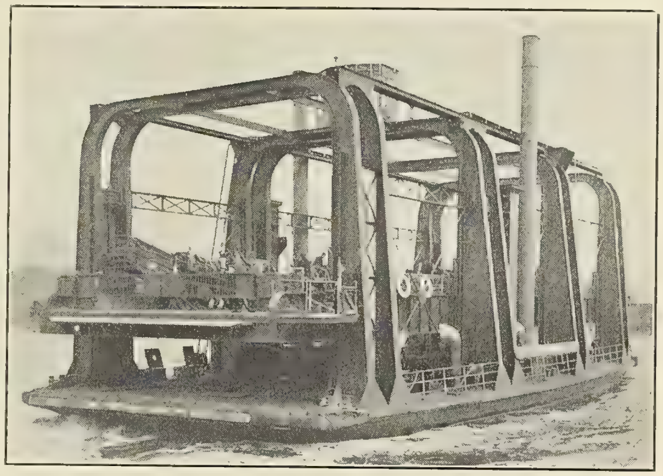
The electric light installation consists of five independent dynamos, each driven by compound coupled engines; and in addition, an emergency dynamo is fitted complete with a boiler in connection with the passage, deck and masthead lights. The ventilation of the vessel is unusually complete for hot climates and, in addition to the usual methods, electric fans are fitted throughout.

The appliances for mooring the ship include a large steam windlass, two steam capstans forward, and two steam warping capstans aft. The cargo loading and discharging facilities are very complete, eight cargo hatchways being served by ten powerful hydraulic cranes, which operate with little noise—a fact which will be much appreciated by passengers.

A UNIQUE FERRYBOAT.

An elevating vehicular ferry steamer was recently constructed by Messrs. Ferguson Bros., Port Glasgow, for the trustees of the Clyde Navigation for service in Glasgow harbor at Finneston. This vessel, which is known as the *Finneston No. 1*, is 104 feet long, 45 feet wide, with a molded depth of 12 feet 6 inches. She was built to British Corporation Survey requirements, and has a Board of Trade certificate for carrying passengers.

The elevating platform which carries the vehicles has a range of 17 feet, and is carried on eight double-threaded buttress screws of forged steel, the screws being hung on collar bearings in cast steel brackets, which are supported by the framing legs. The platform is built up of H girders, closely pitched and connected at the ends to massive built steel girders on either side of the vessel. The supporting screws are fitted with worm wheels, of special material, at the lower ends gearing with forged steel worms all working in oil baths. A separate triple-expansion three-crank engine is fitted for the purpose of raising or lowering the main platform. This engine is of the inverted type, and connects to the worms by machine-cut bevel and spur gearing of cast steel, an automatic gear is fitted on this engine to prevent the platform from being raised or lowered beyond its intended travel. A brass indexed tell-tale is also fitted in a prominent position in the engine room, showing the exact position of the platform in feet and inches.



FINNESTON NO. 1.

The lower or main deck is of steel plating, and has no projections above 10 inches, allowing the platform to come to the lowest possible level during a very high tide.

The main propelling engines are of the vertical three-crank triple-expansion type, each engine driving two propellers, one forward and one aft, two thrust blocks being fitted on each line of shafting. The engines are controlled from the house on top of the framing by balanced rods, the latter actuating the steam valves on the direct-acting steam and hydraulic reversing engines. There are no rudders, the vessel being maneuvered entirely by the propelling machinery. In the controlling house the two reversing handles are situated one on each side of the steersman's position. Two Chadburn's direction tell-tales and tachometers are also provided and fixed in this house, giving the number of revolutions and direction of the propelling engines. Chadburn's telegraphs to the main and elevating engines are also fitted, the former being intended for use only in case of emergency.

Steam is provided by two return tube marine boilers, having a working pressure of 160 pounds per square inch. The main condenser is separate from the main engines, and is fitted with two of Baker's exhaust steam purifiers. The air pumps are independent, steam driven by two crank compound engines, and are in duplicate, one set being kept as a stand-by. This also applies to the independent centrifugal circulating pumps. Electric light is fitted throughout.

The boiler feeding is effected by Weir's automatic float-tank pumps, the feed-water passing through a Weir's heater and Harris filter before entering the boilers. Cameron's pump is fitted for bilge and wash-deck service.

The vessel throughout is of massive design, all parts having been carefully constructed for their respective purposes. The platform is intended to carry sixteen loaded lorries, but with a mixed cargo as many as twenty vehicles can be accommodated on board.

The vessel was launched with all her machinery on board and with steam up.

A LONGITUDINALLY-FRAMED SHIP.

BY BENJAMIN TAYLOR.

The oil tank steamer *Paul Paix*, built by Messrs. R. Craggs & Son, Ltd., Middlesbrough, for the Lennards Carrying Company, Ltd., has the distinction of being the first ship built on the Isherwood system of construction, in which longitudinal framing takes the place of the closely-spaced transverse frames familiar in ordinary vessels. With this system of construction, transverse strength is obtained by fitting on the shell and deck plating a series of strong transverse members at widely-spaced intervals. These transverses extend completely around the sides, bottom and deck of the ship and are slotted to permit longitudinal frames and beams being fitted continuously throughout the length of the ship. It is claimed that by using this system of construction the ship can be built of greater strength with the same weight of material than when the ordinary form of framing is used, or, that the same strength can be obtained with a less weight of material. It is also claimed that construction is simplified, and that the dead weight carrying capacity is considerably increased.

The *Paul Paix* is an oil tanker, subdivided into sixteen separate oil tanks, designed to carry 6,400 tons dead weight, and special arrangements are made to enable her to load down to full load draft with a cargo of motor spirits with the same facility as with denser oils. The ship is 367 feet long over all, with an extreme beam of 49 feet 6 inches and a molded depth of 28 feet. She is a single-deck ship, having a continuous expansion trunkway above the oil tanks. Propulsion is by means of quadruple expansion engines fitted amidships, steam being supplied by three main boilers abreast. There are two complete cargo-pumping installations of unusual power, designed to deliver the fuel cargo into shore tanks in a few hours.

FIG. 1.—VIEW OF THE PAUL PAIX, UNDER CONSTRUCTION, SHOWING STRONG TRANSVERSE MEMBERS.

The coaling arrangements are very simple and very little trimming is necessary, the cross bunker forward of the boiler room (A, in Fig. 2) being the main permanent bunker. The bridge space is utilized for reserve bunkers. A double bottom, available for carrying oil fuel or water ballast, is fitted in the machinery spaces.

In order to avoid any break in the longitudinal strength, the trunk is continued through the bridge, and the arrangements provide for practically the same longitudinal strength through the machinery space as in way of the oil tanks at each end of the bridge, the omission of the center bulkhead being compensated for by the longitudinally-stiffened bridge and double

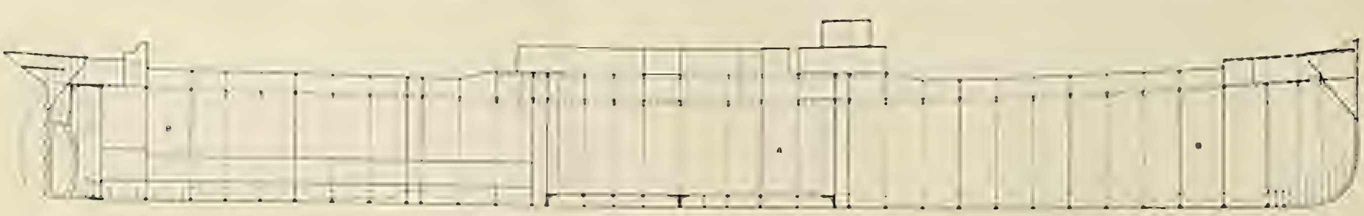


FIG. 2.—INBOARD PROFILE OF THE OIL TANKER PAUL PAIX.

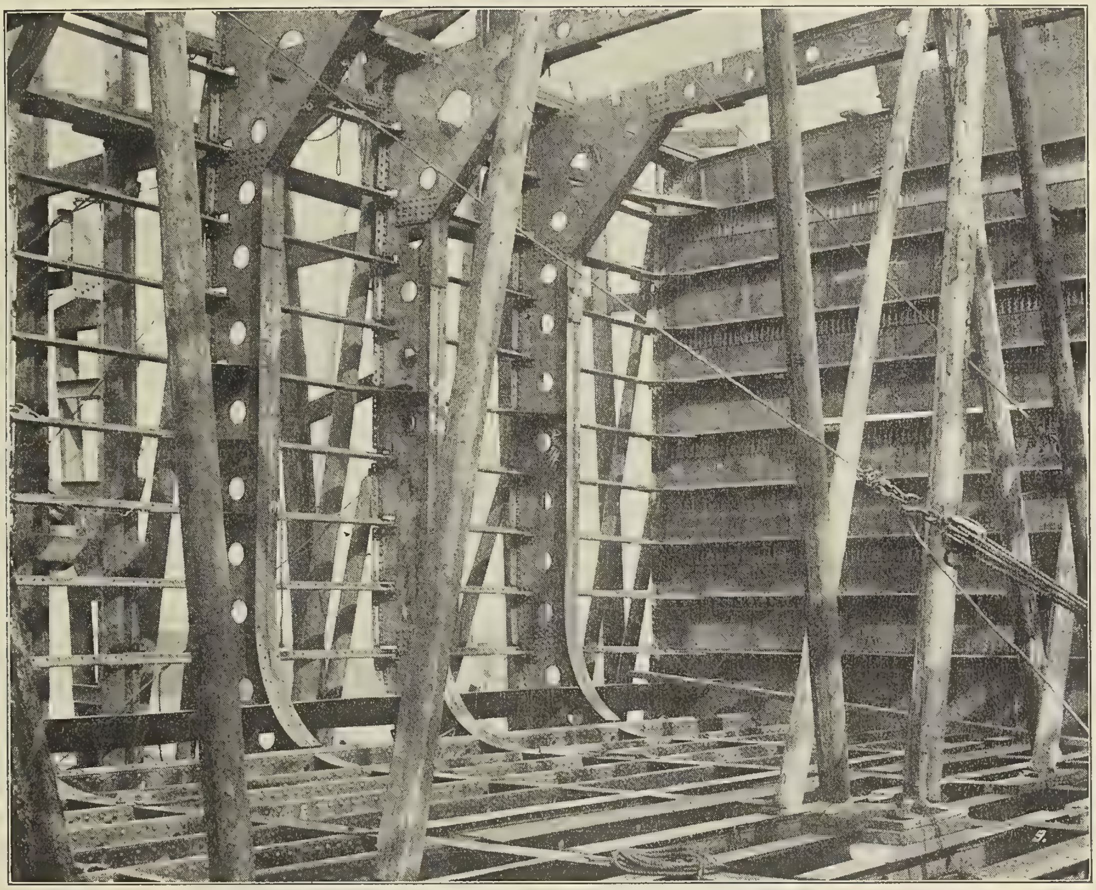


FIG. 3.—FRAMING OF THE PAUL PAIX.

bottom. The tank abaft the engine room is for carrying part cargo of refined spirit and is fitted with a cofferdam at each end. The short tanks at the ends of the vessel (B, B, in Fig. 2) provide for taking a cargo of spirit when more capacity is required than for carrying heavy oils, or these tanks may be used as supplementary tanks for special uses.

The main oil tanks are 30 feet long, and two transverses are fitted in each of these tanks. The transverses are 35 inches deep at the side, 20 inches across the deck, 39 inches at the bottom and 33 inches at the center-line bulkhead. They are formed of 18-pound plates and are connected to the shell plating by double angles. Double-faced angles are fitted 5 x 4 x ½ inches. In the engine and boiler space, practically the same spacing of transverses is maintained. In way of the

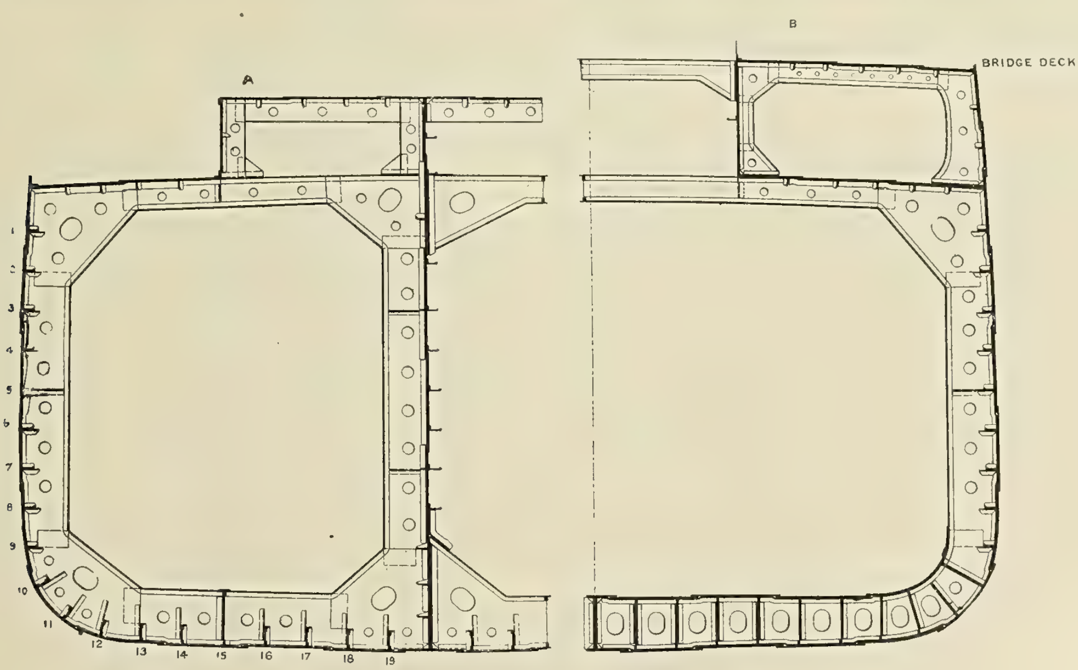


FIG. 4.—MIDSHIP SECTION OF THE PAUL PAIX.

FIG. 5.—LONGITUDINALS.

double bottom the alternate transverses are fitted continuously around the bottom to the center line, and the longitudinal girders are fitted in long lengths between these transverses, to which they are efficiently attached. The remaining transverses are stopped at the deep girder in the double bottom next the margin plate, and are then fitted intercostally between the longitudinals to the center line. The margin plate is fitted intercostally between the transverses and connected to them by double-riveted water-tight collars.

The uppermost bulb angle (longitudinal) below the upper deck (No. 1, in Fig. 4) is 8 x 3½ x 13/32 inches amidships, and is reduced to 7 x 3½ x 13/32 inches at the ends; the lowest bulb angle (No. 9) is 9½ x 3½ x 19/32 inches, and the intermediate bulb angles are graduated in size according to the depth of immersion. They are spaced 29 inches apart. The bottom longitudinals are 15 inches by 16 to 14 pounds, graduating in depth to 12 inches at the upper turn of the bilge; the angles at the top and bottom of these girders are 3½ x 3½ x 13/32 inches. The deck longitudinals are 7 x 3 x 13/32 inches amidships, except in way of the bridge, where they are 5½ x 3 x 13/32 inches and they are also this size at the ends of the vessel. They are spaced about 27 inches apart. The longitudinal materials at the upper and lower parts of the structure for about the amidship half length are increased in

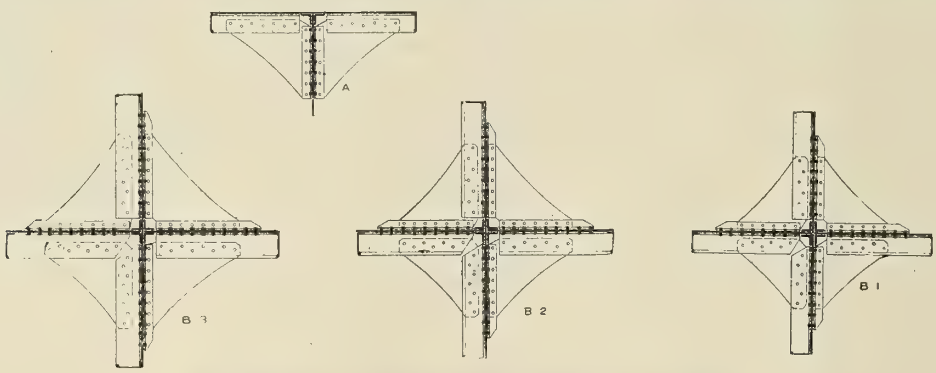


FIG. 6.—DETAILS OF CONNECTION TO STRINGERS AND BULKHEADS.

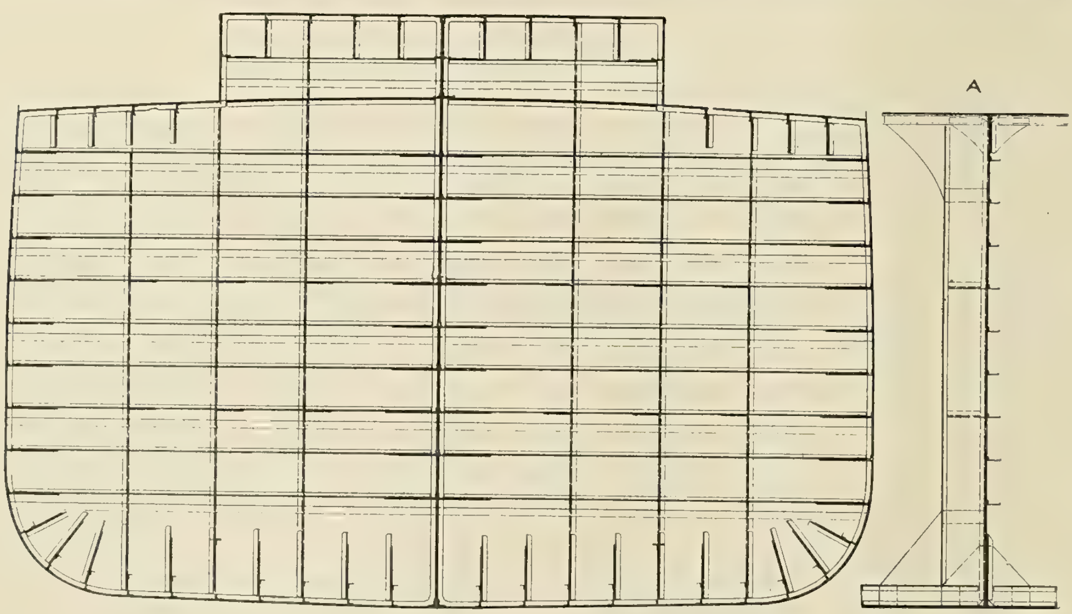


FIG. 7.—TRANSVERSE BULKHEAD, SHOWING STIFFENERS.

strength beyond that required to resist the water pressure, because these parts are also subject to bending stresses. The trunk deck longitudinals at the sides of the hatchways are 7 x 3 x 11/32 inches bulb angles; those in between the hatchways are reduced to 5½ inches.

The upper deck and trunk sides are of 20-pound plate, the upper deck stringer plate is from 24 to 18 pounds clear of bridge and 20 pounds in the bridge. The stringer plate at the bridge ends is 32 pounds. The trunk stringer plate and trunk deck center plate are 20 pounds. The sheer strake is 24 pounds in way of the bridge, 32 pounds at the bridge ends and 18 pounds at the ends of the vessel; the side plating is from 22 to 18 pounds, and 24 to 18 pounds alternately, and the bottom plating is 26 pounds amidships, 18 pounds in the fore peak and 20 pounds aft. The bridge side strakes of plating are 18 and 16 pounds respectively. Three strakes of plating at each side of the keel plate have their midship thicknesses maintained to the collision bulkhead, and the flat part of the bottom from No. 4 bulkhead (numbering from forward) to the collision bulkhead is additionally strengthened by fitting double 6 by 6-inch angles to the transverses and double angles 3½ by 3½ inches to the longitudinals.

The plate edges up to the strake below the sheer strake are parallel to the keel, and the spacing of the longitudinals at the ends of the vessel does not exceed the midship spacing, but is in some parts closer than amidships. The longitudinals are also so arranged that the crossing of the plate edges is almost avoided. The uppermost longitudinal on the middle-line bulkhead in the trunk is a 7 x 3 x 11/32-inch bulb angle, and the bottom longitudinal is 9½ x 3½ x 9/16 inches, the intermediate stiffeners being graduated in size. The transverse bulkheads (Fig. 7) are supported on one side by three-deep web plates A on each side of the middle line bulkhead and on the opposite side with horizontal stiffeners in line with the longitudinals on the side plating and the longitudinals on the center-line bulkhead. The sizes of these horizontal stiffeners are graduated according to their depth of immersion in a similar manner to those at the sides of the vessel and on the center-line bulkhead. The longitudinal frames and beams and longitudinal stiffeners on the center-line bulkhead are cut at the transverse bulkheads, and are fitted with brackets efficiently connected to the stiffeners and bulkheads.

The Telephone Equipment of the Lusitania.

Of the many new features which go to make the Cunarder *Lusitania* and her sister ship the *Mauretania* the most up-to-date passenger steamships afloat (in their facilities for promoting comfort for their passengers and facilitating good service), the private branch telephone equipment is highly important. We believe this to be the first instance where a complete private branch exchange, giving regular exchange facilities, has been installed on an ocean-going liner. This apparatus was specially designed by the engineering department of the Western Electric Company to meet the requirements peculiar to such an installation.

The equipment consists of a switchboard having a capacity of 200 stations, 89 of which are now in use, and 20 exchange lines, 10 of which are in use when the vessel is in port. The switchboard and the exchange apparatus is located amidships in a room set apart for that purpose. The switchboard is of special design, the power panel for controlling the ringing generators being placed on top of the switchboard proper. This power panel is used for charging and discharging the batteries and has mounted on it the necessary switches and measuring instruments.

The telephones used are of special design and construction, as shown in Fig. 1. The body is of metal, gilded or silvered to harmonize with the furnishings and general color scheme of the room decoration in which it is used. The bell, induction coil and condenser are mounted in a neat box having a white enameled cover. In most cases these bell boxes are completely out of sight and the wiring between them and the instruments is run behind the paneling of the cabins. The switchhook is designed to grip the receiver and prevent the latter from falling down or knocking against the side of the instrument when the ship rolls. That part of the switch hook

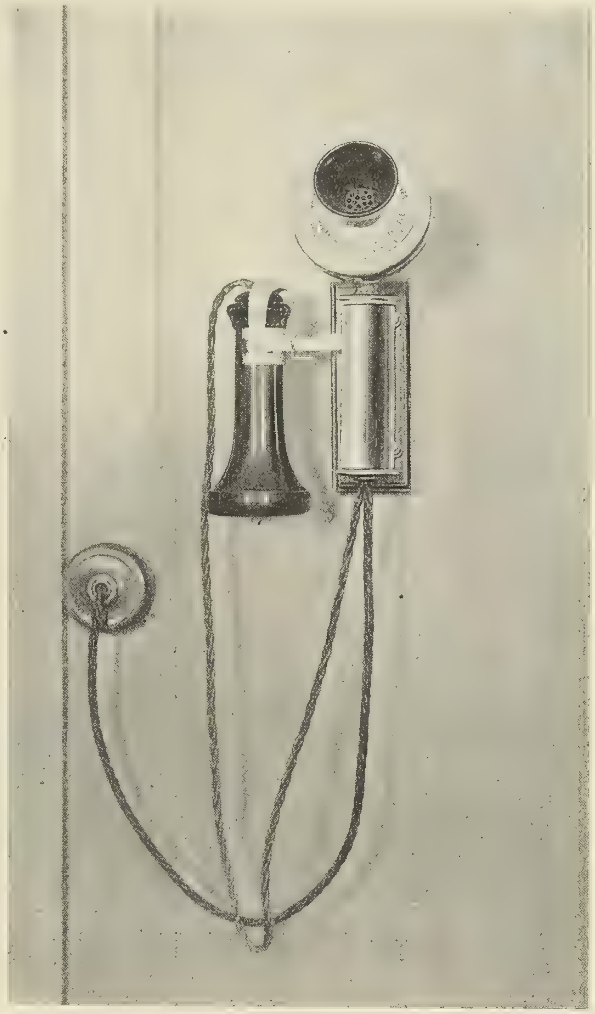


FIG. 1.—TELEPHONE INSTRUMENT, SHOWING SPECIAL CLIP FOR HOLDING RECEIVER.

which holds the receiver is also pivoted horizontally so that the receiver may swing with the ship and always tend to maintain the active length of the lever. If this provision were not made the swing of the ship would lift the lever, owing to the shortening of the distance between the center of gravity of the receiver and the fulcrum of the lever. This arrangement has proved highly satisfactory and its use will doubtless become universal for this class of service.

The telephones used on this liner are installed in the regal and suite staterooms, in the cabins of the purser, the ship's doctor, the chief steward and in the information bureau. This enables the passengers to communicate with any of these departments without leaving their rooms. The hundred and one little things that come up during a voyage can be quickly arranged with the least possible trouble to the passenger. Passengers in different parts of the ship can communicate with each other, and all the advantages of a telephone on land are possible here.

For further convenience of the passenger a system has been

arranged by which he can communicate with those on shore right up to the time the ship leaves her dock. This is accomplished by connecting the ship's exchange with that of the city. Ten pairs of wires for the exchange junction lines are carried in a lead-covered cable from the switchboard to each side of the ship, where they are terminated in a box of special design. On the landing stage or dock where the ship is berthed a series of similar boxes is arranged, each having ten junction lines from the city exchange terminating in them. These boxes are so placed that in whatever position the ship is berthed one of them will be in easy reach of the box on the ship. A length of flexible cable containing ten pairs of lines and fitted at each end with a special cable head is provided for effecting connection between the ship's box and the

FIG. 2.—STATEROOM, SHOWING TELEPHONE INSTRUMENT.

shore box. At the Liverpool landing stage three of these shore boxes are provided and similar ones are to be provided in New York.

The telephone system also greatly aids in the actual working of the ship. On the bridge there are two pillar 'phones, which enable the officer on watch to speak to the steering gear compartment, the engine room, the starting platform, the after bridge, the forecastle and the crow's nest. When the officer on watch receives the information from the lookout in the crow's nest, he immediately calls up the engine-room platform. From the engine-room platform communication can be had with the chief engineer's offce, the steering-gear compartment, the pump rooms and the dynamo rooms. Communication is also afforded between the captains, officers, stewards, pursers, the Marconi house and the information bureau.

The chief steward uses the telephone to order from the various store rooms whatever may be required for the bill of fare, as well as to give instructions to his assistants regarding their duties. The purser and those of this department use the telephone almost continuously, while the information bureau is always busy.

From this it is seen that the principal officers of this vessel, whether the navigators, engineers or administrative officials, find immediate use for the telephone. In fact, in a vessel like the *Lusitania,* where the passengers and crew number over 3,000, a telephone system becomes a necessity. The results obtained from the use of this system on the *Lusitania* have been so satisfactory that it is only a question of time before all our big liners will be similarly equipped.

Magnetic Survey Yacht Carnegie.

The Carnegie Institution of Washington has recently placed a contract with the Tebo Yacht Basin Company, of Brooklyn, N. Y., for the construction of a magnetic survey yacht, to be built after designs by Mr. Henry J. Gielow, of New York. This boat is unique in that all the materials entering into its construction are to be non-magnetic, a fact which prohibits the use of iron and steel in the construction of all the machinery and fittings. The motive power, which is to consist of producer gas, further prohibits the use of copper and brass in the gas producer and parts of the engine in contact with the gas. Bronze, manganese metal and gunmetal will be largely used in the construction of the machinery.

The principal dimensions are: Length over all, 155 feet 6 inches; length on load waterline, 128 feet 4 inches; beam molded, 33 feet; depth of hold, 12 feet 9 inches; with a mean draft of 12 feet 7 inches, and a displacement of 568 tons with all stores and equipment on board.

The hull will be constructed of wood; the keel, stem, sternpost, frames and deadwood to be of white oak; the beams and planking of yellow pine, and the deck of Oregon pine. The fastenings to be locust tree nails, copper and Tobin bronze bolts and composition spikes. All deck fittings, metal work on spars and rigging will be of bronze and copper, and the rigging will be of hemp.

The vessel will have full sail power, being rigged as a hermaphrodite brig, carrying just under 12,900 square feet of plain sail. In addition to this there will be an auxiliary power plant consisting of a six-cylinder, internal combustion engine capable of developing 125 indicated horsepower at 350 revolutions per minute, which, driving a feathering propeller of special design, will give the vessel a speed of six knots in calm weather. The engine will be operated by gas generated in a producer gas plant. The vessel will carry 25 tons of coal in her bunkers, which will give her a cruising radius of 2,000 nautical miles at a speed of six knots.

The living quarters are all below; ventilation and lighting being obtained by means of a cabin trunk on deck about 42 feet 8 inches in length, 16 feet 6 inches in width and 3 feet in height, and safety will be secured by means of six transverse watertight bulkheads dividing the vessel into seven compartments. The officers' and crew's quarters will be forward, 42 feet in length, occupying the full width of vessel; next will be the quarters for the scientific staff 38 feet in length and extending the full width of the vessel; and abaft of this will be the machinery space, 23 feet in length. The living quarters have been planned to give good accommodations for all, and will be fitted with all necessary conveniences.

The observation room and observatories are located on the main deck amidships, and consist of a central observation room with circular observatories forward and aft of it. The observation room will be 14 feet 6 inches long and 16 feet wide, and the observatories will be circular, 7 feet 6 inches in diameter, each fitted with a revolving dome, constructed of bronze framework and plate glass. The joiner work will be in white pine painted, with hardwood trimmings finished bright.

The first voyage of the *Carnegie* will be to the North, visiting Hudson Bay and Greenland.

Centrifugal Pump Fire Boats.

An abstract of a paper, read by Mr. Charles C. West before the Society of Naval Architects and Marine Engineers, describing the centrifugal pump fireboats recently built for Chicago, was published on page 539 of our December, 1908, issue. This paper included data taken on an eight-hour test on one of these boats, the results of which, as given in the advance copies of the paper, showed that 4,800 gallons of water were discharged per nozzle per minute. This figure was subsequently corrected when the paper was read to 4,808 gallons, making a total of 9,616 gallons per minute for the boat.

The steam consumption of the turbines per B. H. P. per hour was given in the paper as 18.4 pounds, and the coal consumption per B. H. P. per hour was 2.82 pounds. Since the trial was made, however, it was discovered that the impellers of the pumps had been fitted too closely, and were rubbing badly, so that it was necessary to take them out and give them more clearance. The figures given in the paper, as published, therefore, for the B. H. P. of the turbines are quite unreliable, and the actual B. H. P. was undoubtedly considerably more than the amount stated. How much more it is impossible to say, as there is no way, of course, to determine what the increased resistance in the pumps caused by this excessive friction of the impellers was. It may be stated, however, that all four sets for the two boats, that is, the turbines, generators and pumps, were thoroughly and carefully tested at the works of the General Electric Company, at Schenectady, before shipment to Manitowoc, and that the water consumption per B. H. P. was found to be 15.8 pounds, the efficiencies of the pumps varying from 70 to 75 percent. These results were obtained with a steam pressure of 160 pounds, a vacuum of 30 inches and with dry steam. The B. H. P. developed was 675. In the Manitowoc test, described in the paper, the moisture in the steam, determined by calorimeters, placed close to the turbine throttles, was 2.3 percent. Assuming that the steam consumption of the turbines went up to 16.25 pounds, which seems a fair allowance, the B. H. P. would have been about 1,325, the efficiency of the pumps about 67 percent, the B. H. P. per square foot of grate surface about 15.8, and the coal per B. H. P., with no deduction for the auxiliaries, about 2.5 pounds, corresponding to about 2.25 pounds per indicated horsepower. All these figures, it should be remembered, are the averages of fifteen-minute readings, extending over a full eight-hour period, including all the necessary cleaning of fires, with the same fire-room crew for the whole test.

Since then more clearance has been given the impellers, and the pumps have been put through the required four-hour test, running absolutely dry without the slightest trouble of any kind, and a subsequent examination of the impellers showed no sign of rubbing whatever.

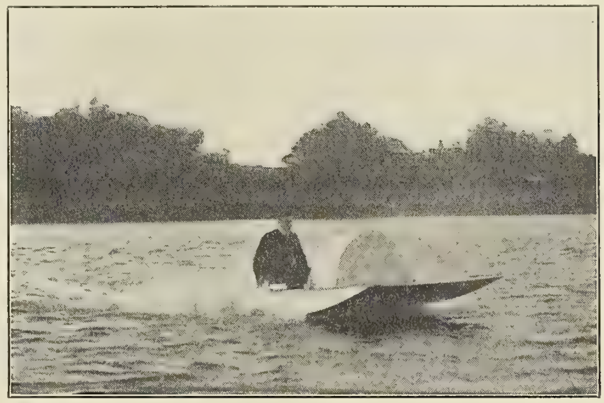
The Harbor Tug Essayons.

A new type of harbor tug has just been completed by the Racine Boat Manufacturing Company for the United States government, to be used by the Engineers' Department on Lake Superior in the vicinity of Duluth. This boat was designed by government engineers primarily for use as an ice-breaker, for the purpose of clearing the canals in midwinter. She is 86 feet long over all, with a beam of 21 feet and a draft of 10 feet 6 inches. The hull is constructed entirely of steel with extra heavy frames, and with double plating at the bow for encountering heavy ice. The bow is sharply cut away under water, while the underbody amidships and aft is of comparatively large displacement, thus giving a form of hull which will allow the forward part of the boat to slide up on heavy ice and crush its way through.

The *Essayons* is propelled by a fore-and-aft compound engine, having cylinders 16 and 34 inches diameter, with a common piston stroke of 26 inches. Steam is furnished at a working pressure of 180 pounds per square inch by a fire-box boiler having 1,560 square feet of heating surface. The boat was designed for an average speed of 12 miles per hour, and is fitted with a steam steering gear. Heavy towing bits and Sampson posts are also provided at the bow and stern, as the tug is expected to prove herself of value for towing purposes.

The First Successful English Hydroplane.

Since experiments were first made with hydroplanes, interest has centered in the speeds which could be attained on given powers with this type of boat. The photograph shows a hydroplane 13 feet long with a beam of 5 feet 6 inches, equipped with a three-cylinder, 12-horsepower Brooke motor, which has already attained a speed of approximately 20



THE SURPRISE AT FULL SPEED.

statute miles per hour. This boat was built by J. W. Brooke & Company, Ltd., Lowestoft, who claim that she is the first successful English hydroplane to be built. She is equipped with a solid propeller fixed well below the surface of the water, which is driven by the motor through a universal joint. Trials are now being carried out with different propellers, and it is expected that, as soon as the most efficient propeller is found, the speed already attained will be increased.

THE DEVELOPMENT AND PRESENT STATUS OF THE EXPERIMENTAL MODEL-TOWING BASIN.

BY H. A. EVERETT, S. B.

In probably no branch of naval architecture or marine engineering do scientific observation and deduction play such an important part as in the modern model-towing basin. What the research laboratory is to the advanced chemist and physicist, this becomes to the present-day shipbuilder, so before proceeding with a description of the existing tanks and their operation, it will be of interest to review the steps leading up to the establishment of the pioneer tank of Wm. Froude, in 1872.

Over two centuries ago, scientists interested themselves in the resistance a floating body offers to forward movement, and theories and opinions concerning the form necessary for least resistance were advanced by such men as Newton, Bernouilli and Euler, which were fortified, in many cases, by formidable mathematical work. Their results, however, were so slightly confirmed by practical experiments that they were of little value. In 1770 the French Academy of Sciences organized a commission for resistance investigation, consisting of D'Alembert, Condorcet and Bossut, who were to collaborate with Borda in deducing from his experiments (of 1763-'67) and others a mathematical formula which should give a form of least resistance, and it is here that we strike the keynote of the fallacy that apparently ran through all the

work up to Froude's time, namely, the belief that a *single* form existed which offered *least* resistance under *all* conditinons of speed, displacement, and length. To us at present this seems hardly conceivable, and yet traces of it appear, even to-day, in the experiments sometimes carried out. Borda's experiments included some ship-shaped solids, but were mostly concerned with mathematical solids, as prisms, cylinders, etc., and along a similar line the French vice-admiral, Thevenard, worked at Lorient. Later (1775-'94) the Swedish chief constructor, Chapman, attempted to find out the influence of the location of the maximum section in solids of rotation with parabolic or conical ends, but the solids were small (28 inches long) and his results did little to advance the cause.

Col. Marc Beaufoy carried out experiments in England about this time (1793-'98), which may be considered to be the beginning of the present method of attacking the problem. He towed a large number of solids, some submerged and some floating, in the Greenland dock. A run of 400 feet was obtained, and the water had a depth of 11 feet. The models were drawn by a heavy weight suspended from three large sheer legs forming a tripod nearly 60 feet high. (See Fig. 1.) The absolute motion of this was multiplied by pulleys, and the time and speed automatically recorded on a batten by a pendulum. The experiments were originally undertaken in 1791 at the instigation of the "Society for the Improvement of Naval Architecture" (now out of existence), which furnished some financial backing, but were completed by Col. Beaufoy from his own resources. The models used were largely geometrical, though some approximated ships' forms, but the value of his work was in his segregation of the frictional resistance and the study and analysis he made of it. He carried out experiments for this upon planks of varying lengths and tabulated the frictional resistances. The models were of wood, painted.

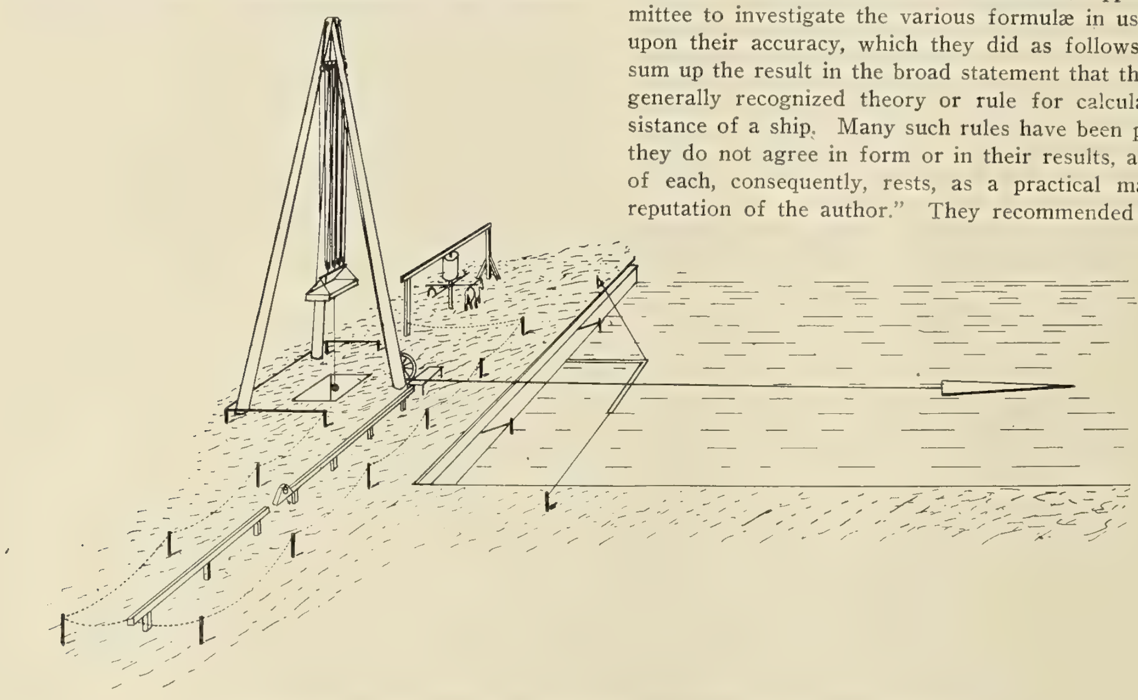


FIG. 1.—TOWING APPARATUS USED BY COL. MARC BEAUFOY AT THE GREENLAND DOCK.

The interest in experimental work along this line seems to have flagged about the last of the eighteenth century, and though numerous scientific discussions appeared, little additional research work was attempted until the middle of the nineteenth century, when steam, as a motive power, made its appearance, and it became imperative to have information regarding the power necessary to obtain a certain speed in order to build engines in accordance. This brought forth additional experiments, which were in the direction of towing tests[1] of actual steamers.

From the results of these towing tests and what trial-trip data were available, many formulæ for power were advanced by the authorities[2] of that time, all of which were largely empirical. Based as they were, on tests of vessels not modern, even at that time, and many upon sailing ships, they depended so largely upon the personal knowledge and experience of the user that they were of little value outside of the originators' hands, and even there, within but narrow limits.

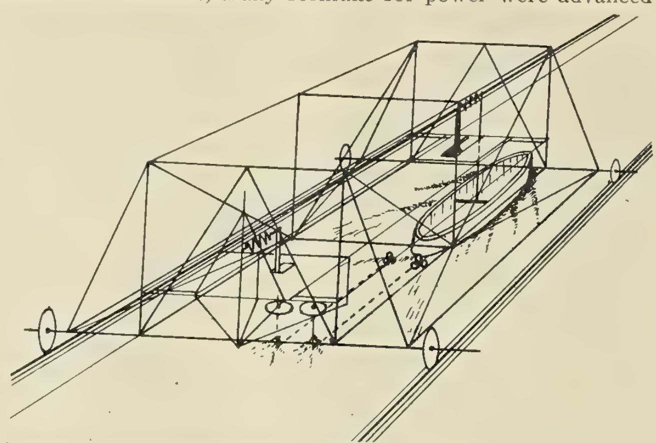


FIG. 2.—DIAGRAM OF TOWING CARRIAGE USED BY FROUDE IN HIS EARLY EXPERIMENTS AT CHELSTON CROSS, TORQUAY.

About this time the British Association appointed a committee to investigate the various formulæ in use, and report upon their accuracy, which they did as follows.[3] "We may sum up the result in the broad statement that there exists no generally recognized theory or rule for calculating the resistance of a ship. Many such rules have been put forth, but they do not agree in form or in their results, and the credit of each, consequently, rests, as a practical matter, on the reputation of the author." They recommended the carrying out of more towing experiments on full-sized ships, Froude dissenting.

Up to this time the resistance not due to friction, when dif-

[1] Towing experiments were carried out by Dupuy de Lome & Jaffe and Admiral Bourgois upon the following vessels: 1840, *Sphinx* (wooden steamer); 1846, *Purgouin* (schooner); 1848, *Fabert* (brig); 1853, *Morceau* (wooden frigate); 1856, *Duperre* (battleship); 1861, *Elorn* (frigate).

[2] Tredgold, Campaignac, Bourgois, Dupuy de Lome, Nystrom, Thorneycroft, Guide & Jay, Isherwood, etc.

[3] Merrifield, "First Report of the Committee of the British Association, Exeter meeting, 1869."

ferentiated at all, had been assumed to be a direct displacement resistance, that is, the resistance was assumed to have a relation to the actual quantity of water (equal to the displacement) which the ship moved aside in passing, and it remained for Scott Russel to bring forth the theory of wave-making resistance as a distinct and separable factor. Professor Rankine, in 1866, published his stream-line theory.

The modern attack began with the resumption of towing experiments upon *ship* models by William Froude[4] about 1870. tion. This was accepted, and the first real model-towing basin was constructed at Chelston Cross, Torquay, near his home. This was not, by any means, an elaborate structure, for it is very doubtful if anyone at that time looked upon it as more than a temporary structure, which would be done away with when the experiments should be finished. It was simple and complete, and in the hands of a master like Froude, it turned out wonderful work. In fact it has served as a pattern for all later tanks.

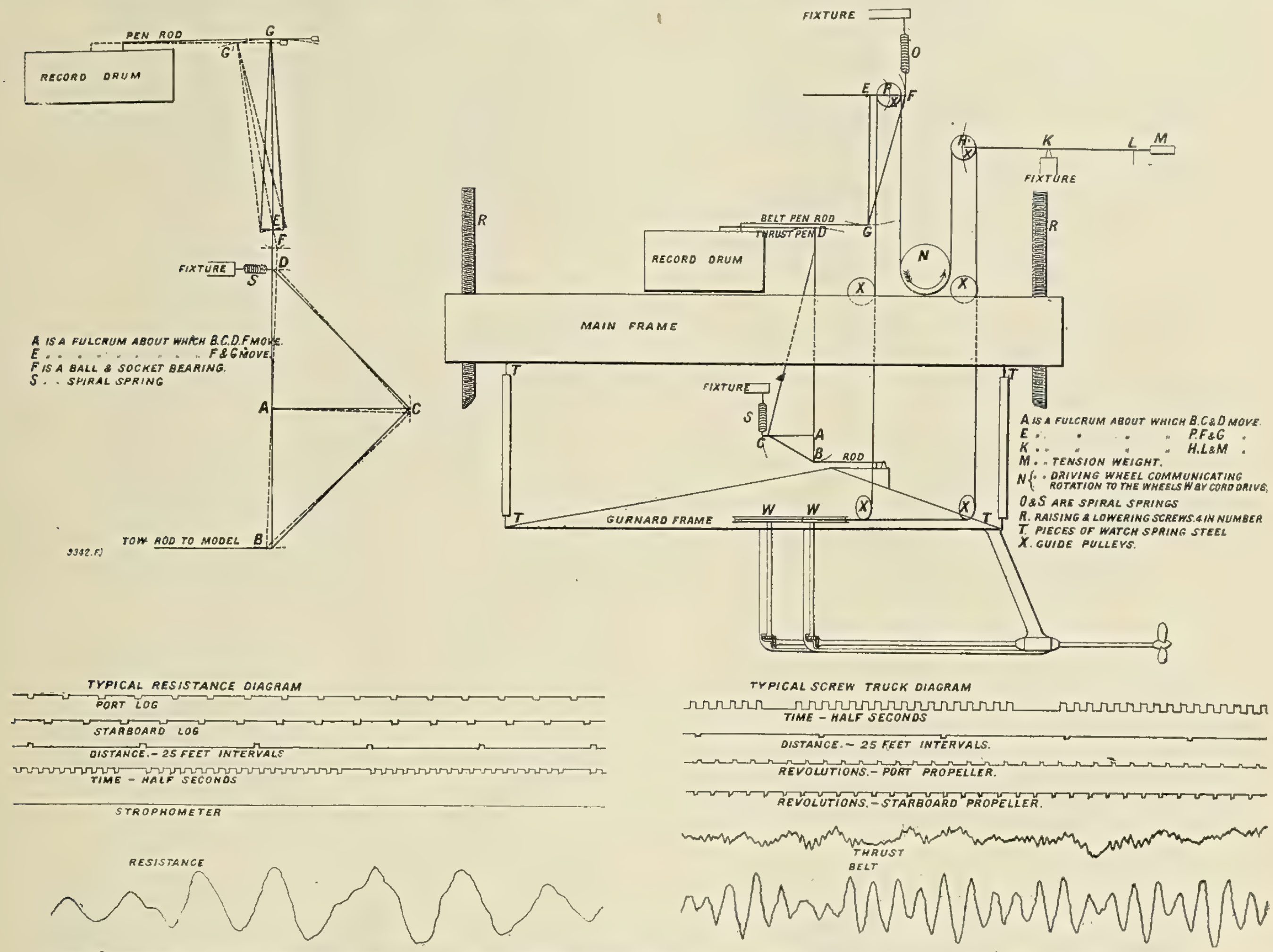


FIG. 8.—DIAGRAMMATIC REPRESENTATION OF APPARATUS FOR RECORDING MODEL RESISTANCE, AND PROPELLER TURNING MOMENT AND THRUST.

He was a member of the before-mentioned committee of the British Association, and, in an appendix to their report, made the proposal to carry out towing experiments upon models. He held that from *accurately* carried-out experiments upon *carefully* made ships' models, results would be obtained which would permit making a perfectly definite and correct estimate of the power necessary to drive the full-sized ship, represented by the model, at speeds *corresponding* to those at which the model was towed. He objected to the resumption of towing experiments upon full-sized ships, on the grounds that the large number of types that must be taken and the expense in time and money to carry them out made it impracticable. Acting upon the suggestion of Sir E. J. Reed, he drew up a proposal and estimate for an experimental sta-

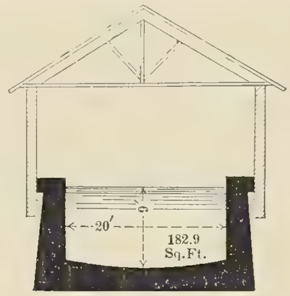
[4] Wm. Froude was a civil engineer by profession, and was associated with Mr. Brunel in many of his railway problems, retiring in 1846. When Mr. Brunel was superintending the building of the *Great Eastern* he requested Mr. Froude to carry out experiments on friction for her launching (1869). Later, Froude investigated the rolling of ships and built the foundation of the present theory of waves. In 1869 he was appointed one of a committee of six of the British Association, as above stated, to report on "The State of Existing Knowledge on the Stability, Propulsion and Seagoing Qualities of Ships, and as to the application it is desirable to make to Her Majesty's Government on these subjects."

Froude was a practical mathematician and his principal service to the world lies more in the careful analysis he made of his towing experiments and his development and presentation of his "Laws of Comparison," whereby the results obtained upon models could be enlarged to the scale of the full-sized ship than in the equipment of this first tank. The tank itself was 300 feet long by 36 feet wide by 10 feet deep. The sides were sloping and of asphalted earth, and the light wooden carriage running on tracks suspended from the roof was drawn by a stationary engine at one end of the tank.

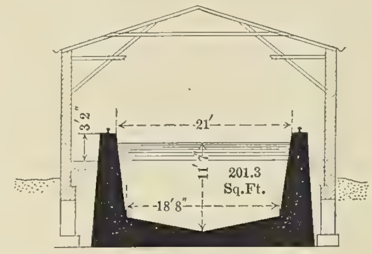
On the completion of the tank, Froude immediately began his experiments. Considerable divergence of opinion existed as to the reliability of tank experiments, and Mr. Scott-Russell, while admitting the value of *comparative* experiments upon different models, said that in his opinion experiments with small models were "quite remote from any practical results on a large scale,"[5] but he reckoned without his host, for Froude, acting for the Admiralty, carried out his famous

[5] Trans. Inst. N. A., 1870. Vol. XI., p. 82.

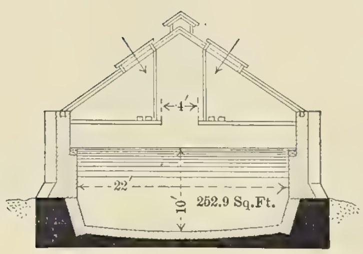
"Greyhound" experiments.[6] The *Greyhound* was a screw sloop of 878 nominal tonnage without masts, and this ship Froude towed from a 45-foot boom, rigged out over the starboard side of H. M. S. *Active* at varying speeds and displacements. He took three displacements, and at each three different trims; in each condition she was tried at speeds ranging from 3 to 12½ knots. Upon the curve of resistance on speed which he obtained from these experiments, he superposed the curve which he obtained from towing a model of the *Greyhound* (1/16 the actual size) under each of the different conditions to which the ship herself had been subjected. The curve obtained from the model experiments practically coincided with that obtained from the towing of the ship herself, a splendid confirmation of his faith in model experiments, and from that time *carefully* carried out experiments upon the *exact model* of the proposed ship have given us the surest estimate of the power to be required.



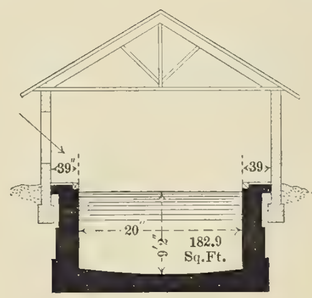
JOHN BROWN & CO., CLYDEBANK, SCOT.



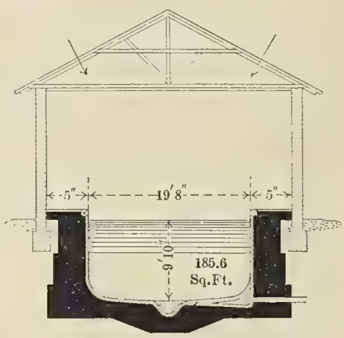
GER. GOV'T & TECH. HOCHSCHULE, DRESDEN, GER.
(THE NEW UBIGAU TANK)



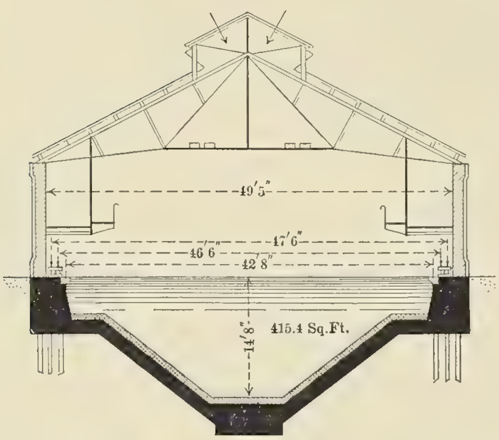
WM. DENNY & BROS., DUMBARTON, SCOT.



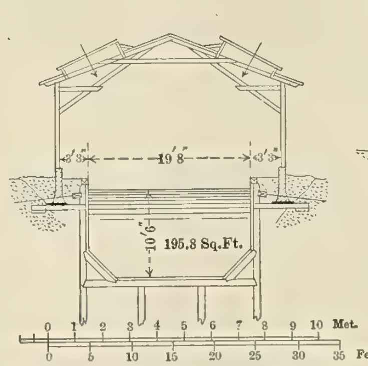
BRITISH ADMIRALTY, HASLAR, ENG.



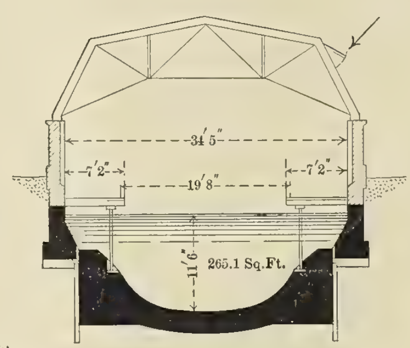
ITALIAN GOV'T, SPEZIA, ITALY



U.S. GOV'T, WASHINGTON, U.S.A.



N. GER. LLOYD, BREMERHAVEN, GER.



GER. GOV'T AND CHARLOTTENBURG TECH. HOCH., BERLIN, GER.

PLATE I.—CROSS SECTIONS OF PRINCIPAL EXPERIMENTAL MODEL-TOWING BASINS NOW IN EXISTENCE.

Froude's vindication of his theories was so complete that towing experiments were resumed with renewed vigor, closely following, however, the lines laid down by him. The Dutch Naval Constructor Tideman equipped a tank similar to that of Froude in one of the Royal Docks of Amsterdam and towed paraffine models up to 30 feet in length. His work on frictional resistance of model and ship surfaces is standard to-day. (Memoriaal van de Marine, Amsterdam, 1786.)

France undertook similar work at Brest, when Risbec inaugurated the towing of wooden ship models covered with tinfoil, but modified Froude's method to the extent of towing models from a floating platform, which was itself towed.

In Italy the work of Lettieri along the same line was undertaken in a dock with the towing apparatus stationary on shore, after the order of Beaufoy's.

Froude's method of carrying out his model experiments, as well as his machinery therefor, has been copied practically in its entirety by the subsequent establishments, except for minor changes and improvements, and a description of one, in a general way, will apply to nearly all. The model carefully constructed, as described later, to the exact form

[6] Trans. Inst. N. A., 1874, p. 59. Discussion by Wm. Froude, of *Greyhound* experiments. "The experiments with the ship, when compared with those tried with her model, substantially verify the law of comparison which has been propounded by me as governing the relation between the resistance of ships and their models. This justifies the reliance I have placed on the method of investigating the effects of variation of form by trials with varied models; a method which, if trustworthy, is equally serviceable for testing abstract formulæ as for feeling the way towards perfection by a strictly inductive process."

of the ship, is towed at various speeds from a carriage spanning the tank, and its resistance, trim and speed automatically and continuously recorded on apparatus located on the towing carriage. There is also propeller apparatus on the carriage for recording the revolutions, turning-moment speed, and thrust of the model propellers. The model is usually towed both with and without the propellers in place behind it. Figs. 2 and 3 show the carriage, and, diagrammatically, both the model and propeller apparatus, with typical diagrams, as installed in one of the most recent tanks. (John Brown & Co., Ltd., Clydebank.) As the speed through the water may not be the same as the speed of the carriage on account of currents in the tank, a measure of these currents is made by the revolutions of two log screws running in advance of the model, and a graphic measure of speed from a strophometer is recorded for detecting any lack of uniformity of speed.

William Froude also carried out experiments upon the frictional resistance of planes of different surfaces from 2 to 50 feet in length, which form the basis of our present-day estimate of skin resistance of ships. Upon his death, in 1879, his son, R. E. Froude, who had been his assistant, was appointed by the Admiralty to carry on the work, and a new tank was constructed at Haslar, England.

Meanwhile, Mr. Wm. Denny, of the Clyde shipbuilding firm of Wm. Denny & Bros., had been so impressed with the value of tank experiments that his firm had built a private establishment in 1884 very similar to that at Torquay, and inaugurated the custom of towing models of all ships built by them. This firm built many paddle-wheel steamers, some of them of very high speed, and in these the location of the paddle wheels to take advantage of the wave formation thrown up by the ship was one of the points readily solved by tank experiments. It placed them in a position to guarantee speed and to take the position of pre-eminence that they did for this type of boat. Following is a list of the tanks at present in existence, and Plates I. and II. give a general idea of the arrangement of each:

PRINCIPAL EXISTING MODEL—TOWING BASINS.

Date	OWNER	Place	Length	Breadth	Depth	Run	Section.
1884	W. Denny & Bros....	Dumbarton, Scot....	300	22	10	250	
1886	Brit. Admiralty.....	Haslar, Eng........	400	20	9	360	
1889	Italian Gov't........	Spezia, Italy........	538	19.7	9.9	480	
*1892	"Kette" S. B. Co. (old Uebigau tank).	Uebigau, near Dresden, Ger..........	206	24.6	4.5	206	
1893	Russian Gov't.......	St. Petersburg......	441	21.8	11	374	
1899	U. S. Gov't.........	Washington, U.S.A..	470	42.7	14.7	384	
1900	Cornell Univ........	Ithaca, N. Y.,U.S.A.	418	16	10	418	
1900	N. Ger. Lloyd S.S. Co..............	Bremerhaven, Ger....	541	19.7	10.5	476	
1902	Tech. Hochschule & Ger. Gov't........	Berlin, Ger.........	557.7	34.4	11.5	479	
1903	John Brown & Co...	Clydebank, near Glasgow, Scot....	445	20	9	400	
1904	Tech. Hochschule & Saxon Gov't (new Uebigau tank)....	Uebigau, near Dresden, Ger..........	312	21.0	11.3	288	
1906	Univ. of Mich.......	Ann Arbor, Mich, U. S. A..........	300	22	10	275	
1906	French Gov't.......	Paris..............	525	32.8	13.1	442	
1907	Mitsubishi S. B. Co.	Nagasaki, Japan....					

NOTE.—The length, breadth and depth are the overall distances at the water surface and the depth is at the center line. The run is the length, exclusive of the docks, etc., at each end and the date is that of beginning experimental work.
* Now discontinued.

(*To be continued.*)

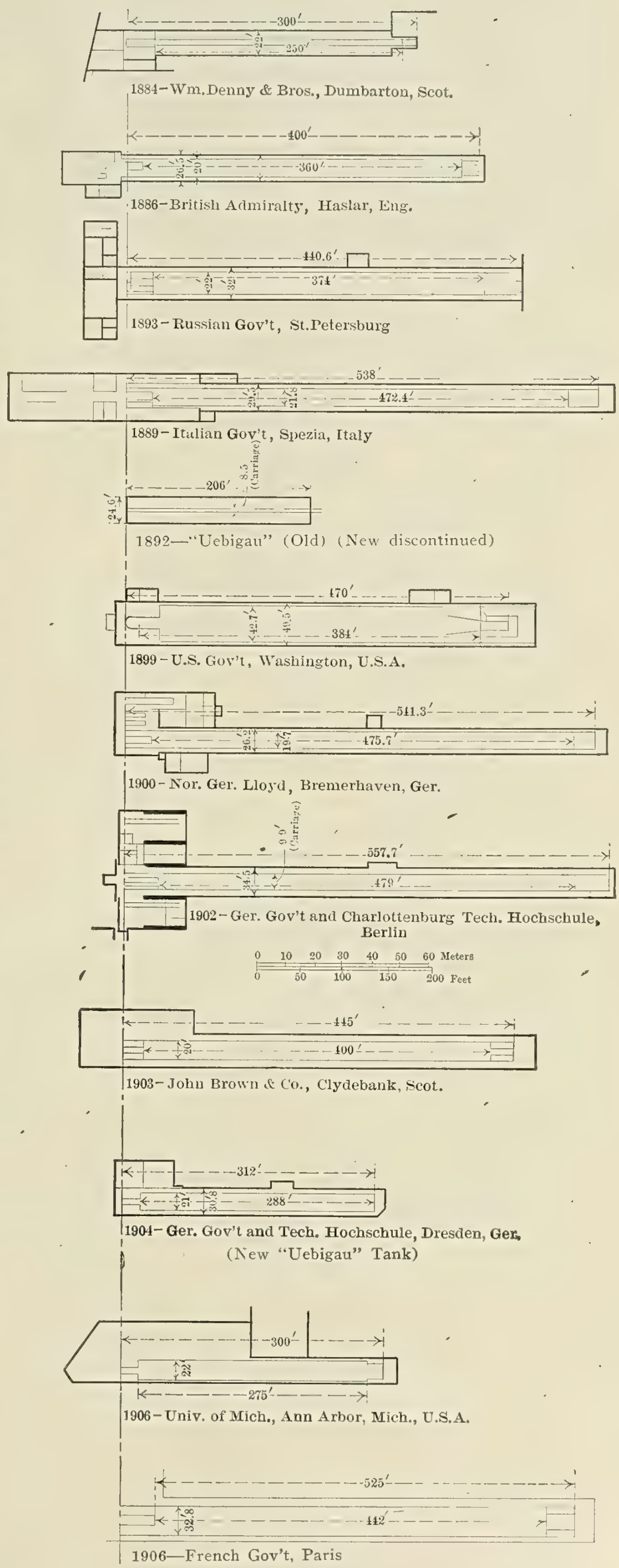


PLATE II.—PLAN OF TANKS NOW IN EXISTENCE, SHOWING PRINCIPAL DIMENSIONS.

INTERNATIONAL MARINE ENGINEERING

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Notice to Advertisers.
Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

Government versus Private Work.

The controversy over the relative merits of naval work done in government establishments and in private shipyards is of long standing. One of the things which has always counted heavily against the government establishment is the lack of engineers sufficiently well trained in certain specialized lines. This is true in both the United States and England. In both countries most of the machinery for naval vessels is obtained from contractors, and, in the case of recent ships propelled by turbines, this work has been done by certain concerns which have secured the services of highly skilled and specially trained men who are thoroughly acquainted with the design, construction and operation of steam turbines. Since nearly all of the repair work, however, is carried out in government dockyards or navy yards, this machinery passes at once under the supervision of men whose knowledge of engineering is, on the whole, of a more general nature than that of the men employed by the builders. The results, as set forth by one of our correspondents this month, need little comment.

In the United States the work of designing naval machinery, the general supervision over repairs to naval machinery, the examination and supervision of machinery plans in detail submitted by contractors engaged in building government vessels, and the collection and arrangement of engineering data of the world's progress in naval engineering, are done at the Bureau of Steam Engineering, under the supervision and direction of line officers detailed for engineering duty only. The need is now being acutely felt for a greater number of younger officers adequately trained for this service. Undoubtedly the greatest efficiency results when the officers who design naval machinery are also the ones who superintend its construction on shore, and, later, its operation at sea; for only in this way can they acquire familiarity with all the needs of the service.

The opportunities which a young line officer has for instruction and development under such close association with engineering work in the navy are exceptional. In navy yards the engineering work of such officers includes the making of estimates for repairs, deciding upon their necessity, preparing designs for alterations and repairs and supervising and conducting the work when authorized both on shore and on the ships. The field for instruction and development for a young line officer on duty at a private shipbuilding yard, supervising the inspection of machinery for vessels under construction, is one of the best, especially if such officers are detailed to those posts with a view to their assignment to the ships under construction after they are completed. By their close personal contact with the machinery during this construction and the final stages of its assembly on board the ship, and by their presence and observation during the preliminary and full-speed trials, they acquire a mass of information about the machinery and ship in general which makes their services of the greatest value to the government during the succeeding years in which the ship is in service. It is generally admitted by officers of the navy that whatever excellence is attained in the equipment of ordnance, propelling machinery, auxiliaries, electrical equipment, etc., is due very largely to the fact that the officers who inspected the materials and superintended the construction on shore were the same ones who afterwards at sea supervised their operation.

There is a vast field for improvement in the design and installation of naval machinery, and also in the administration of government establishments. The expense of repair work at navy yards is notoriously large compared with the expense of similar work carried out by contractors, and this can be reduced only by closer and better supervision of machinery details and greater economy in navy-yard management and administration. What little constructive work has been done in the United States navy yards has entailed considerably more expense and taken a greater length of time than similar work performed in private shipyards, the most notable case being the construction of the battleships *Connecticut* and *Louisiana*. The *Connecticut*, constructed in the Brooklyn Navy Yard, cost $390,280 (£80,340) more than the *Louisiana* and

required four months longer in building. It sometimes happens, however, as in the case of one of the battleships now being built in England, that the constructive work is carried out with all possible speed at a dockyard, only to have the completion of the ship delayed by the non-delivery of her machinery and ordnance, due to labor troubles at the contractors' works; but that is a condition of affairs which seldom happens.

Perhaps it is not strange that the highest efficiency is not maintained in a navy yard or dockyard where the work done is of such a miscellaneous character, ranging, as it does, all the way from the manufacture of ships' stores to the construction of the ship itself, and the total product of any one thing is such a comparatively small amount. Good results would hardly be expected from a strictly commercial establishment under these conditions. However, the fact remains that, in general, naval work can be done by contractors more cheaply, more expeditiously, and more efficiently than in government establishments; and, until conditions are changed, contractors are likely to remain far in the lead. This is the fact which most vitally concerns the people whose money is being spent for this work, and for whom the work is being done.

Trade Papers in Europe.

At a recent meeting of the Technical Publicity Association in New York, President Redfield made a comprehensive statement regarding the status of trade papers in Europe. In general, foreign trade papers seem to be of little value to the average business man, principally on account of the poor editorial quality of the publications. It has been the case in America that nearly all successful trade papers have first created their own demand by the excellent editorial quality of the magazine, and have then proceeded to fill this demand until now the mission of the trade paper is a definite one and its place in the business world a definite place. Mr. Redfield stated that theoretically the proper paper for an American to advertise in is one which is printed and distributed in the country which he wishes to reach, but practically it seems likely that good trade papers printed in America and intelligently distributed abroad may be better mediums than the feeble efforts which are the rule rather than the exception abroad.

Due to the fact that International Marine Engineering covers a field which is world-wide, we have had ample opportunity to test the truth of the above statements. When, three years ago, the extent of our circulation in Great Britain and Ireland seemed to justify the publication of an English edition, we entered this field not only with the idea of being better able to serve the interests of our readers by presenting at first hand the conditions which prevail in foreign shipyards, and especially those of Great Britain, the greatest shipbuilding center in the world, but also with the expectation of finding a definite place in the English business world. The results have amply fulfilled our expectations, and to-day we have evidence that our magazine has found a definite place in the business world, not only in the two countries in which it is published, but all over the world, as testified by our large circulation in all countries where there are maritime interests. We have found that people all over the world look to the two great English-speaking nations not only for engineering data but also for the dissemination of engineering information, which, especially in America, is not jealously guarded as a trade secret.

Model Towing Tanks.

When the bulk of shipping was carried in sailing vessels the shipbuilder was not as vitally concerned with the question of the resistance which a floating body offers to forward movement as is the builder of iron steamships to-day. Early designs of sailing vessels were based on the results of practical experience at sea and it was the aim of the builder to secure the best sea-going and sailing qualities for his ship. The result of years of experience with all types of ships gave him all the information he needed on this score. Fast sailing ships were therefore the result of a process of gradual development rather than of the direct application of the principles of theoretical naval architecture. With the advent of the steamship, however, it became important to know how variations in the shape of the hull affected the resistance which the ship offered to propulsion through the water and also the exact relation between power and speed for any ship. It was soon recognized that these and various other similar problems could best be investigated by means of towing experiments on small models of the ship itself provided the results obtained from such tests could be applied to the full-sized ship. The connecting link between the theoretical and practical application of such experiments was offered by William Froude in the development and presentation of his "Laws of Comparison," whereby the results obtained upon models could be enlarged to the scale of the full-sized ship, and this, as pointed out by a writer elsewhere in this issue, was Mr. Froude's principal service to the world.

Once established, towing tanks have become an important and almost indispensable adjunct to the leading navies of the world and also to the private shipbuilder. Besides the tanks owned by different countries and by shipbuilders, which are usually supplied with very complete and expensive equipment, a number of smaller tanks have been established at various engineering schools where naval architecture is taught. While the equipment of these tanks is less elaborate, the work carried out at them is often of the greatest value, because, unhampered by commercial considerations, they are available for a great amount of valuable research work.

Progress of Naval Vessels.

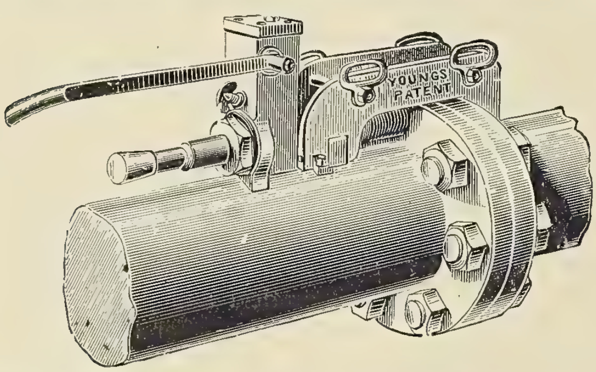
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Nov. 1.	Dec. 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons.........	65.9	69.9
Michigan ...	16,000	18½	New York Shipbuilding Co..	74.9	79.4
Delaware ...	20,000	21	Newp't News S.B. & D.D. Co.	50.3	54.9
North Dakota	20,000	21	Fore River Shipbuilding Co..	58.8	62.8
TORPEDO BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons.........	57.5	59.9
Lamson	700	28	Wm. Cramp & Sons.........	56.2	58.5
Preston	700	28	New York Shipbuilding Co...	52.0	54.9
Flusser	700	28	Bath Iron Works............	33.0	40.9
Reid	700	28	Bath Iron Works............	31.6	38.5
SUBMARINE TORPEDO BOATS.					
Stingray ...	—	—	Fore River Shipbuilding Co..	62.3	64.5
Tarpon	—	—	Fore River Shipbuilding Co..	60.3	63.0
Bonita	—	—	Fore River Shipbuilding Co..	57.8	60.8
Snapper	—	—	Fore River Shipbuilding Co..	56.5	58.2
Norwhal ...	—	—	Fore River Shipbuilding Co..	52.3	54.8
Grayling ...	—	—	Fore River Shipbuilding Co..	52.0	53.5
Salmon	—	—	Fore River Shipbuilding Co..	51.3	52.8

ENGINEERING SPECIALTIES.

Youngs' Patent Hollow Ram Hydraulic Bolt Forcer.

Youngs' patent hollow ram hydraulic bolt forcer is constructed principally for forcing in and out coupling bolts, but it is also suitable for various other purposes, such as forcing pins, etc., in and out of machines, and removing drums from the shafts of winches when fitted with a special cross-head and bolts. The novelty of the invention consists in having a hollow steel sliding ram, the ends or tails of which project through the front and back respectively of the cylinder. Inserted in this hollow ram is a steel drift, which passes right through the center of ram; a head is forged on one end of the steel drift, a shoe for the bolt is fitted on the other. The



method of working is the same as in any ordinary hydraulic pump, viz.: the fluid is forced by the pump from the reservoir into the cylinder, and the ram is gradually forced forward until it presses the shoe, on the end of the steel drift, against the bolt to be forced out. Should the bolt show no sign of moving out of the coupling when the maximum hydraulic pressure has been obtained, a sharp blow is given with a hammer on the head of the drift, which transmits a shock or "jar" to the bolt and starts it from its position, and it can then be ejected either by pumping the ram forward or knocking it out by hammering on the head of the steel drift. Thus the device combines both the push and the blow or "jar." A release or stop valve is provided for the return of the liquid to the cistern, after unscrewing which the ram can be pushed back ready for another stroke. Another valuable feature consists in the easy portability of the machine, which is a great consideration in shaft tunnels or other cramped spaces; for this purpose the body can be separated from the arms or claws by withdrawing two sliding bolts, when the machine can be carried in two separate pieces and the body placed first in position on the shaft and the claws lifted up afterwards.

These machines are manufactured by Youngs, Ryland street works, Birmingham.

The A B C Life Preserver.

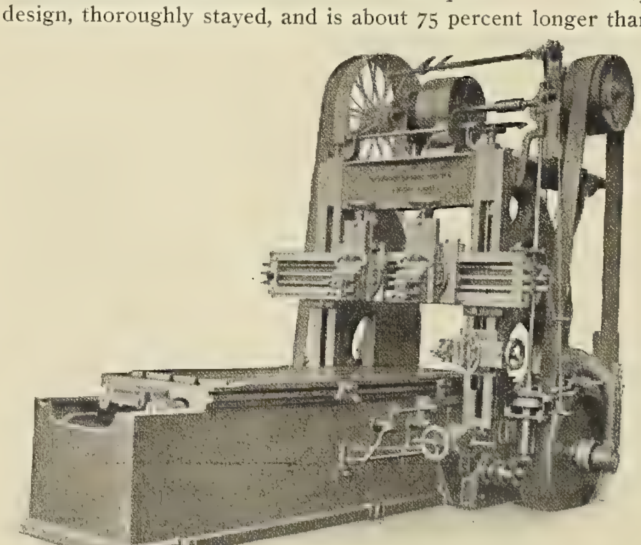
A new life preserver is soon to be placed on the market by the Lane & De Groot Company, of New York. This life preserver, as shown in the photograph, is made in the same way as the old-style cork preserver, with the exception that the cloth cover and straps are of better quality and the stitching is more carefully done. The principal feature of this preserver is, of course, the means employed for obtaining the required buoyancy. The manufacturers have made use of a material which is about one-third lighter than cork. They have,

A B C BELT. CORK BELT.

therefore, been able to reduce the size of the life belt very materially, and, of course, the weight is reduced a corresponding amount, while maintaining a greater buoyancy than with the ordinary cork belt. The material used in the belt is coated with a solution which entirely prevents water or dampness from the atmosphere from being absorbed. It is also fireproof. The advantage of having a waterproof material is, perhaps, the most important, as far as the life of the belt is concerned, since this preserves the covers and straps from mildew and rot. This life preserver has been approved by the Board of Supervising Inspectors; and, due to its many advantages, will undoubtedly be widely used.

The Bateman "Top Speed" Planer.

A combination of high speeds and accurate work in planing has been sought in the design of the Bateman top-speed planer. manufactured by the Bateman's Machine Tool Company, Ltd., near Hunslet, Leeds. The bed of the planer is of heavy design, thoroughly stayed, and is about 75 percent longer than

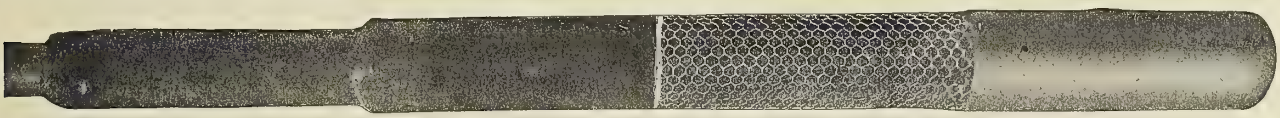


the stroke of the table. The table itself is deep and well ribbed, the ways being accurately planed and scraped. It is provided with longitudinal T-slots and stop holes, and is fitted with a patented buffer sliding rack, which enables it to be run at high speed and reversed promptly without shock or jar and without damage to the gears. In order to resist the heaviest cuts at high speeds the housings are made of strong design, and the faces afford large bearing surfaces for the cross slide. The cross slide is of sufficient length to carry two tool boxes, both of which travel the entire width between the housings, and have horizontal and vertical feeds in both directions independent of each other. Each tool box is provided with a full swivel index from zero to 60 degrees, the downfeed being fitted with micro adjustment. The automatic feed is of the friction type, and can be started, stopped or changed while the machine is in motion, the pressure on the friction cone being adjusted by means of a spring. All gears used on the machine are cut from solid blanks and the sliding rack is cut from a solid steel slab. The machine is driven at both sides from a countershaft carried on the housing brackets. The patent fly-wheel loose pulleys (with friction clutches between them and the fast pulleys and overlapped by the driving belts) secure exceptionally prompt reversal of the table with great economy of power at the moment of reversal. It is claimed that this patent fly-wheel drive secures such promptness of reversal that the machine will cut to a mark with great precision, the stored energy of the fly-wheel insuring a reliability not always obtainable.

Heat Non-Conducting Material.

In any steam plant economy in fuel consumption is largely affected by radiation, not only from the boiler but from the steam pipes as well. Loss of heat by radiation can be very largely reduced by the use of a good non-conducting covering for the boilers and steam pipes. Whether this will be an advantage or not depends largely on whether the material used for the covering is efficient and durable.

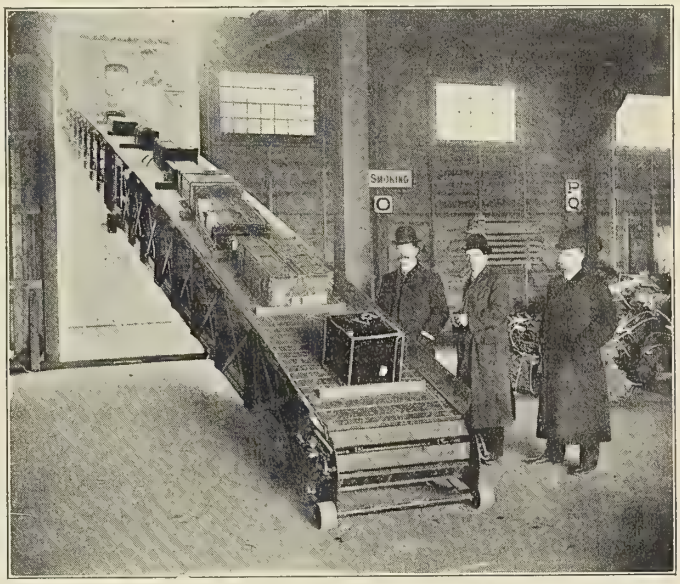
Messrs. Matthew Keenan & Company, Ltd., Tredegar Road, Bow, London, E., have for the last fifty years been making a study of heat insulating materials, and now have on the market as the result of this experience a patent composition for which high efficiency is claimed. On several ships, the boilers of which have been covered by this composition, tests



have been made by the superintending engineers, showing that with a steam pressure of 215 pounds the temperature of the covering was only 4 degrees higher than that of the surrounding atmosphere, which means not only a great saving of fuel but also enables the stokers and coal passers to work in greater comfort. This composition does not require a sheet iron covering on the outside, as it dries to a hard surface. A small mesh-wire covering is placed over the composition, or just under the finishing coat. Should a leak occur in the seam of the boiler, its position will be shown at once, and the wire can then be cut and turned over, the insulation taken out and the seam calked. Afterwards the material can be dampened and put on again, and, after drying, the wire can be placed back in position. The usual method of applying the material, as shown in the illustration, is in three coats, with the wire netting just under the finishing coat. The advantage of using an insulating material which does not require a sheet iron covering is that it enables the engineers to detect leaks and repair them; it keeps the stokehold at a much lower temperature, and a saving in weight of 2½ pounds per square foot is obtained, assuming that galvanized iron of 16-gage would be used for a sheet iron covering.

Spence Portable Electric Conveyors.

Spence conveyors are built of steel frames tapering from the center to the ends, so braced as to give maximum strength with a minimum weight of material. There are roller-bearing steel sheaves on which a flexible steel cable runs, carrying an endless platform, or hardwood apron. It is claimed that this arrangement reduces friction greatly and minimizes the power



needed to operate the conveyors. The conveyors are reversible, so that boxes, sacked goods, barrels, etc., may be taken either up or down. A self-registering counter can also be attached when desired. Extension conveyors are made which can be connected in series and driven from the initial conveyor. Such conveyors can be placed between warehouse or dock floor joists to run flush with the floor, and thus allow trucking back and forth without interference. The illustration shows a 50-foot Spence conveyor loading baggage on the Cunard steamship *Mauretania*.

The headquarters of the Spence Manufacturing Company are at St. Paul, Minn.

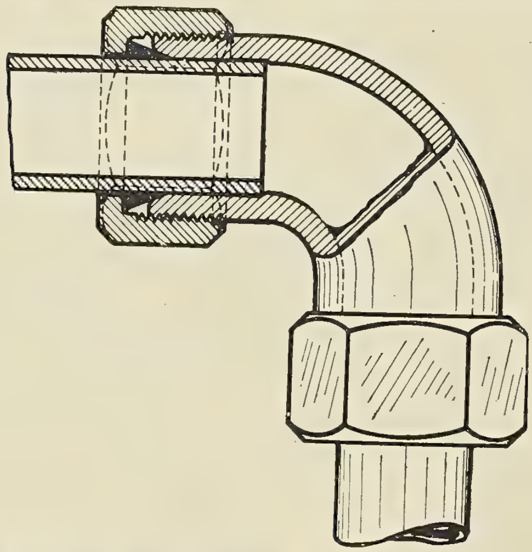
The New Union-Cinch Pipe Fitting.

It is not an easy matter to make a neat job of pipe fitting with small piping where ordinary threaded pipe and tapped fittings are used. Where the work of threading the pipe and getting a good fit for the threads can be accomplished at a factory or in the shop, it is reasonable to expect that the work will be more satisfactory than when done by inexperienced workmen in the field without proper facilities.

The Union-Cinch pipe fitting, manufactured by the Sight Feed Oil Pump Company, Milwaukee, Wis., was designed so that the work of threading could be done in the shop rather than in the field, so that the only tools required in the field are a hack-saw and monkey wrench, except where some complicated bends are to be made when a pipe-bending device of

some sort is necessary. Each fitting is a union, so that the piping may be taken down at any point where a fitting is inserted. The type of joint is clearly shown in the illustration. The joint is made by screwing down the outside nut, which presses a thin, tapered shell into an annular cavity around the pipe between it and the fitting. After these nuts are set up tightly the soft cone shell will make an absolutely tight joint around the tubing, capable of withstanding any pressure which the tubing will stand.

These fittings are made in sizes corresponding to standard iron pipe up to 1 inch, and are especially designed for use in connection with the oil pumps and oilers manufactured by the



Sight Feed Oil Pump Company. It is possible, however, to use ordinary rough pipe with these fittings if care is exercised in filing the ends of the pipe round and smooth, but the manufacturers of the fittings are prepared to furnish smooth-drawn steel tubing corresponding to the iron pipe sizes on the outside diameter. This tubing has a 16-gage wall in the ¾ and 1-inch sizes, and an 18-gage wall in the smaller sizes. This pipe, therefore, has a very much larger carrying capacity than ordinary pipe. In fact, the manufacturers claim that their ⅛-inch pipe will carry almost as much as the ordinary ¼-inch iron pipe. Where it is desirable to have a nice-looking job, brass pipe may be used, although in cases where nickel plating is done a steel tubing will nickel-plate just as well as brass pipe, and is much cheaper.

These fittings are especially valuable in such troublesome work as piping up oil pumps, gravity oiling devices, gages, drop pipes, etc., and especially in work around ammonia-handling machinery, where perfectly tight joints are essential against the escape of ammonia gas.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 421.—What is the meaning of the word inverted as used in the expression "three-cylinder vertical inverted, direct-acting, triple-expansion engine"?

J. H. S.

A.—In the early days of marine engineering engines were often horizontal; an intermediate type, known as the inclined or diagonal engine, is now used to a considerable extent in paddle-wheel steamers, but in modern practice nearly all reciprocating marine engines are vertical. In the earlier vertical marine engines the cylinder was at the bottom, and the motion of the parts proceeded upward either directly to the crank shaft, as in an oscillating engine, or to a beam or intermediate mechanism, whence it came back to the shaft. In the modern engine the cylinders are on top, and the motion of the parts proceeds downward to the shaft. Hence, in comparison to the earlier types, the modern engine is called inverted.

TECHNICAL PUBLICATIONS.

Knocks and Kinks. (*Power* Hand-Book Series). By Hubert E. Collins. Size, 4½ by 6¾ inches. Pages, 137. Figures, 82. New York, 1908: Hill Publishing Company. Price, $1.

This book, which is arranged in convenient size for the desk or pocket, and which has been written especially for the operating engineers, contains the results of the experience of a number of practical men in locating knocks in engines and the kinks to which they have resorted for eradicating the knocks. Most of the common causes of knocks are given, and many which are not so common, but none the less valuable for an engineer to know. The means of detecting the cause of knocks and the remedy to be applied is the chief object of the book. Many interesting instances are given covering both marine and stationary practice.

Machine Shop Calculations. By Fred H. Colvin. Size, 4½ by 6¾ inches. Pages, 174. Figures, 96. New York, 1908: Hill Publishing Company. Price, $1.00.

The calculations described in this book may seem somewhat elementary to many, but will be found invaluable by the man in the shop who has had limited opportunities for education. Everything is described with a view to its application to machine work. Such subjects as the speed of pulleys and gearing, screw-thread calculations, taper work, speed of lathes, planers and shapers, measuring surfaces and volumes of solid bodies, angles, the use of the vernier and micrometer are fully described and illustrated. The final chapter is on the uses of shop "trig," and is followed by a set of trigonometrical tables.

Logarithms for Beginners. By Charles M. Pickworth. Second edition. Size, 5 by 7¼ inches. Pages, 47. New York, 1908: D. Van Nostrand & Company, 23 Murray street. Price, 50 cents net.

In this edition the subject-matter has been slightly revised and a few numerical errors corrected. The book should be a valuable aid to beginners, who find difficulty in grasping the root principle of calculating by means of logarithms. The explanation of logarithms is far more detailed and practical than is usually found in text-books.

Elementary Dynamo Design. By W. Benson Hird. Size, 5¼ by 8¼ inches. Pages, 280. Figures, 128. London, E. C., 1908: Cassell & Company, Ltd. Price, 7/6 net.

Use is made of numerical examples in this volume to illustrate the methods and calculations necessary for the design of dynamo electric machinery. No attempt has been made to go into the controversial points as to the nicety of design, as the book is intended as an elementary treatise. The introductory chapters treat briefly with such points of the theory of electricity and magnetism as are most intimately connected with dynamo design. This is done in order to enable those who take up the subject from the practical side without extensive theoretical training to follow intelligently the reasoning in the succeeding chapters. After describing the various types of dynamos and motors, the question of designing a

continuous-current generator is taken up and the necessary calculations are explained by numerical examples, following which is a discussion of the continuous-current motor. Chapter V. takes up the mechanical details, such as the shaft, bearings, armature spider, commutator construction and brush holders. The general requirements for continuous-current dynamos and motors for special purposes are given some attention. The remainder of the book is taken up with the subject of alternating currents, the design of the three-phase generator, the three-phase induction motor and other varieties of alternating-current motors.

Pipes and Piping (*Power* Hand-Book Series). By Hubert E. Collins. Size, 4½ by 6¾ inches. Pages, 140. Figures, 75. New York, 1908: Hill Publishing Company. Price, $1.

General rules for the design of both high and low-pressure steam piping for power plants are the basis of this work. The reader is given ideas as to the forces to be met and the amount of resistance that can be expected from the pipe and fittings when properly placed. The best arrangement of steam piping for any size plant is given, together with many useful suggestions as to the installation and operation of the system. Expansion and contraction and evaporation in steam pipes are subjects with which the designer must be thoroughly familiar. These subjects are carefully discussed, after which high-pressure steam pipe flanges and methods of packing flanged joints are considered.

Bureau Veritas, 1908-1909. Thirty-ninth year. General list of merchant shipping. Two volumes, steamers. Size, 10 by 7½ inches. Pages, 1,700. Sailing vessels. Size, 7¼ by 9¾ inches. Pages, 1,300. 1908: Paris, 8 Place de la Bourse. London, 155 Fenchurch street, E. C. Price of complete work, £3 3/ ($15). Steamers, £1 15/; sailing vessels, £1 10/.

This well-known publication contains the customary statistics regarding the merchant shipping of all nations, besides a complete list of steamers and sailing vessels in which the principal dimensions, tonnage, builders, construction, mode of propulsion, horsepower and type of propelling machinery and the name and address of the owners are given. There are tables showing the number of ships built, bought and sold in the principal countries during the year; lists of steamers, the names of which have been changed; lists of steamers carrying petroleum in bulk; and a list of cable vessels. There are also alphabetical lists of steamers arranged according to tonnage, and of iron and steel shipbuilders arranged according to nationality, and of steamship owners arranged according to nationality, with the names and gross tonnages of their steamers. A complete list is also given of the drydocks, patent slips and floating drydocks in all parts of the world.

The Mechanical World Pocket Diary and Year Book for 1909. Twenty-second annual issue. Size, 4 by 6 inches. Pages, 395. Figures, 60. Manchester: Emmott & Company, Ltd. Price, 6d. net.

The improvements effected in this year's issue of the *Mechanical World Pocket Diary* include the complete revision and extension of the section on steam turbines, so as to deal more adequately with recent developments in this important branch of steam engineering. The section on friction clutches has also been rewritten and made more comprehensive. A section on chain driving has been introduced, also a note on the graphic calculation of moments of resistance of beams, and tables of the values of I and Z for various sections have been restored. The entire work forms a comprehensive mechanical engineer's handbook, including most all of the mathematical tables for which there is use in current practice.

The Mechanical World Electrical Pocketbook for 1909. Second annual issue. Size, 4 by 6 inches. Pages, 279. Figures, 63. Manchester: Emmott & Company, Ltd. Price, 6d. net.

As this is a book which is published annually, each year will find it enlarged and revised, to include new matter in order to bring it up to date. This year's issue contains valuable data on electric bells and bell circuits, transformation of currents, motor generators, rotary converters, alternate current or static transformers, cables, fuses, circuit breakers, balancers, boosters, electric lifts, electricity in mines, flexible shaft couplings, etc. At the end of the book are mathematical tables for which daily use is found by the electrical engineer, and a complete diary for the year.

Erecting Work (*Power* Hand-Book Series). By Hubert E. Collins. Size, 4½ by 6¾ inches. Pages, 140. Figures, 110. New York, 1908: Hill Publishing Company. Price, $1.

Starting with the subject of foundations, much valuable information is given regarding the best methods of erecting the various items of machinery which are installed in a power plant. The book is thoroughly practical and goes into such detail as the subjects of knots and hitches; the best method of hauling heavy machinery through city streets, and gives the reader an idea of the usefulness of inclined planes, gin poles and various types of rigging for lifting and handling weights. A description is given of the methods of building up a flywheel, and, finally, of erecting a high-speed center-crank engine, together with some incidental lighter work.

Obituary.

Warren Eden Hill, president of the Continental Iron Works, Brooklyn, died at the Hotel Florence, Brooklyn, N. Y., Dec. 8. Mr. Hill was seventy-four years old, and had been identified with the engineering profession since 1852, when he became associated with the Allaire Iron Works, in Newark, N. J. From 1858 to 1862 Mr. Hill was superintendent of the installation of the Detroit water works, and since then he has been associated with the Continental Iron Works of Brooklyn.

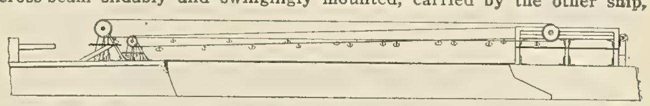
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

903,094. APPARATUS FOR COALING SHIPS AT SEA. ANDREW JOHAN, OF NEW YORK, N. Y.

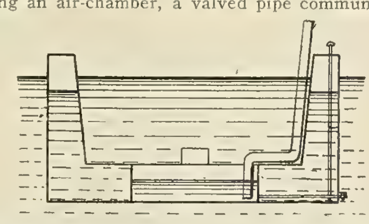
Claim 1.—In an apparatus for transferring at sea material from one ship to another, the combination of sheaves carried by one of the ships, a cross-beam slidably and swingingly mounted, carried by the other ship,



and having sheaves at its opposite ends, continuous cables passing over the sheaves from one ship to the other, on which the material is carried, and a weight connected to the cross-beam for equalizing the strain on the cables and maintaining them under constant tension. Eight claims.

903,215. FLOATING DOCK. ALFRED MEHLHORN, OF DIETRICHSDORF, AND PHILIPP VON KLITZING, OF NEUMUHLEN, NEAR KIEL, GERMANY.

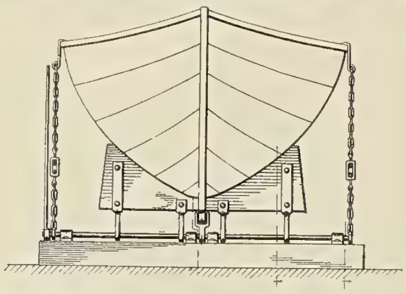
Claim.—A floating dock comprising side chambers, a bottom central pontoon forming an air-chamber, a valved pipe communicating with said



pontoon and leading through a side chamber to the exterior, and an air-tube communicating with said valved pipe and provided with an air-valve. One claim.

903,025. BOAT-HANDLING DEVICE. LEWIS TANNING AND WILLIAM J. RYAN, OF NEW YORK, N. Y.

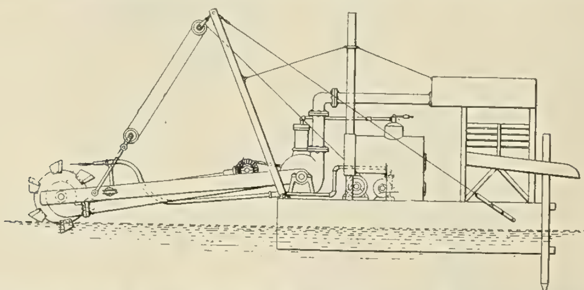
Claim 1.—The combination of a boat provided with a keel and with brackets mounted upon said keel, forks mounted independently of said



boat and provided with rollers for engaging said keel and also for engaging said brackets, and means controllable at will for turning said forks. Three claims.

903,210. DREDGER-CUTTER. ALFONSO LKIEVICZ, OF BERKELEY, CAL.

Claim 2.—In a dredger, a float, a ladder hinged thereto, a cutter consisting of a revolving wheel, digging buckets carried on the periphery of said wheel, said buckets having openings on the side toward center of



wheel, screening devices placed in said openings of buckets, passageways through cutter wheel leading from said openings in digging buckets to side outlet or outlets, a suction chamber to receive the material and a suction pipe connected therewith. Seventeen claims.

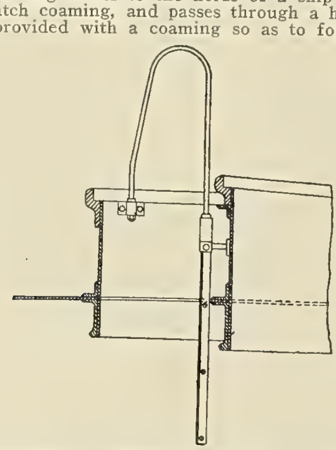
British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

8,530. FURNACES. S. J. ROSS, LONDON; H. SCHOFIELD, MIDDLESEX.

Ordinary steam boilers are provided with means whereby combustion in the furnace is conducted under pressure, which is maintained throughout the combustion chamber and smoke tubes. The front of the furnace and ash pit is closed, compressed air being supplied through a pipe and air-heating passages in the furnace front to the ash pit. The smoke tubes discharge into a box or casing inclosed at the front by a hinged plate to the bottom of which is hinged a counterweighted flap. The flap closes the outlet of the casing and opens more or less according to the rise or fall of pressure.

12,345. SHIPS' LADDERS. H. M. GRAYSON, LIVERPOOL.

A ladder for gaining access to the holds of a ship is secured to the outside of the hatch coaming, and passes through a hole in each deck, this hole being provided with a coaming so as to form a raised man-



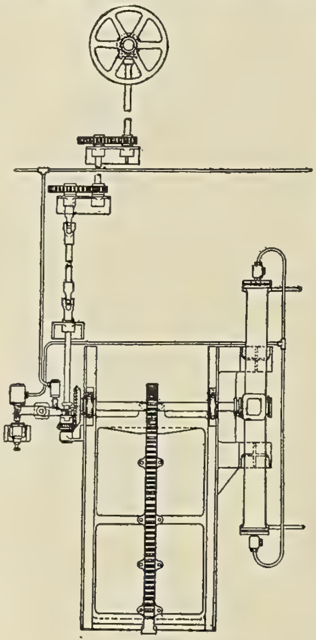
hole. The coaming has a rabbeted upper edge adapted to receive a covering or door. Removal hand-rails fit into sockets secured to the top of the ladder, and to the inside of the coaming. The sides of the ladder are formed of angle, channel, or other bars. A ventilator, such as a cowl, may be placed upon the entrance of the upper man-hole coaming, so that this man-hole serves as a conduit for conveying air into or from the holds.

11,041. PREVENTING CORROSION OF SHIPS' PROPELLER SHAFTS. R. DERENBACH AND RUSSIAN-AMERICAN INDIA RUBBER CO., ST. PETERSBURG, RUSSIA.

A protective covering of rubber is applied to the propeller shafts of ships, in combination with other materials, the cohesion of which is greater than their adhesion to the shaft. For example, the hollow shaft of a ship has its ends closed by blind flanges, and it is warmed up from the inside with steam, and then wound with rubbered or otherwise prepared strips of fabric or plaited material, or rubber composition, with embedded matter. A layer of rubber composition is then ironed on, and the steam pressure is increased until the shaft is brought to a vulcanizing temperature. In covering a solid shaft, the shaft is heated before the fabric strips are wound on, and, after the layer of rubber is put on, the whole is placed in a vulcanizing jacket.

11,095. SHIPS' BULKHEAD DOORS. J. McDONALD, CLYDEBANK, GLASGOW.

Each door is normally actuated by hydraulic pressure, and a clutch is fitted which is capable of automatically engaging or disengaging hand operating gear. When the hydraulic gear is in use the ram acts on the pivoted lever and withdraws the sliding portion of the clutch, and so disengages the hand-operating gear; should the pressure in the pipe suddenly fail, however, a spring in the clyinder throws the parts of the clutch into re-engagement, bringing the hand gear into operation again. A second and smaller ram, connected by a pipe to the main, throws the hand-operating mechanism into gear immediately the hydraulic operating gear is disabled.



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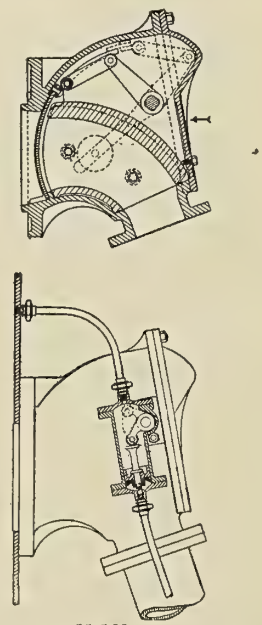

11,162

11,162. SHIPS' SEA COCKS. F. J. TREWENT AND W. E. PROCTOR.

Hydraulic power is employed to open the sea cock of an ash ejector. The sliding valve is connected by links to a spindle, on which is an arm provided with an anti-friction roller, and is operated to turn the spindle by means of a rod connected to the plunger of an hydraulic cylinder. The latter is connected by a branch pipe to the water supply to the ejector, the connection being made at a point between the pump discharge and the ejector cock. A three-way cock is disposed in the branch pipe to enable the cylinders to be placed either in communication with the water supply to the ejector, or with a waste pipe. The exit end of the ejector pipe is formed of renewable segmental and side pieces. A counterbalance weight on the spindle closes the door, when the piston of the hydraulic cylinder returns to its normal position.

11,489. MARINE LIFE-SAVING APPARATUS. A. J. MACLEOD, WEST HARTLEPOOL.

The line connected to the shore by means of a gun firing a projectile is secured to the mast of a ship above a platform, to which persons and articles on deck are lifted in a cradle guided against the mast by guide ropes. The fine connecting line fits in a longitudinal recess in the projectile, and is attached to a ring lying in a recess at its end. The projectile is preferably made of copper, and is hollow.

11,680. SHIPS; PROPELLING BY WATER JETS. C. R. DARLINGTON, LLANBRADACH.

A tube extending the length of a ship is bifurcated at its fore part, and a propeller is placed at the rear of the junction of the two branches. This tube, which is fitted with sluice valves, may be connected to the various compartments, and may be fitted throughout the whole or part of its internal surface with helical ribs formed of angle bars.

12,386. SHIPS. H. A. MAVOR AND MAVOR & COULSON, GLASGOW, AND J. H. BILES, WESTMINSTER.

A turbo-generator plant is employed for supplying the power in vessels carrying derricks, winches and other auxiliaries requiring considerable power, the power generated being used entirely for propulsion, partly for propulsion at a reduced speed, and partly for the auxiliaries, or wholly for the auxiliaries as required. The weight and capacity of the generating plant are thus reduced to a minimum. As applied to a sand-pumping dredger, an alternating current generator, governed to run at a regular, but adjustable, speed by electric means—for example, by a reversible motor driven by an independent circuit, connected with the steam valve—supplies current to the various motors or groups of motors as required for propelling or for driving the pumps and other auxiliaries, which motors may have their stators incorporated in the structure of the vessel. In vessels requiring a variable speed the speed may be regulated by regulating the periodicity of the generator by employing several generators of different periodicity connected up with moors of corresponding periodicity, or by employing motors with revoluble stators which can be positively or negatively driven.

International Marine Engineering

FEBRUARY, 1909.

MAGNETIC SURVEY YACHT CARNEGIE.

Except for a few more or less isolated and incomplete surveys, independently undertaken by various nations and distributed over a great many years, little attempt had been made up to four years ago to determine accurately the magnetic variations all over the deep-water seas. Something over four years ago the Carnegie Institution of Washington undertook this work, organizing a department of research in terrestrial magnetism, and placing the entire work under the directorship of Dr. L. A. Bauer, who was formerly in charge of the Magnetic Survey of the United States under the Coast and Geodetic Survey.

The first step in the ocean work was to make a magnetic survey of the Pacific Ocean, where little had been done except making shore observations on some of the islands and along the coast. Observations were made from the converted wooden yacht *Galilee,* which, between Aug. 1, 1905, and May 31, 1908, or in somewhat less than three years, made three successive voyages in the Pacific, tracing the Great Circle route, and zigzagging in and out among the islands, making the total length of these cruises over 60,000 miles. The most northerly point visited by the *Galilee* was Sitka, Alaska, and the most southerly one was Lyttleton, New Zealand. This is only the beginning of the work, however, as the Institution has already made magnetic observations in many parts of the globe, and now has two expeditions in Africa, one in China, one in Persia and Asia Minor, and has already covered a part of South and Central America, British North America and Greenland. It is estimated that a magnetic survey of the world can be completed in about ten years more.

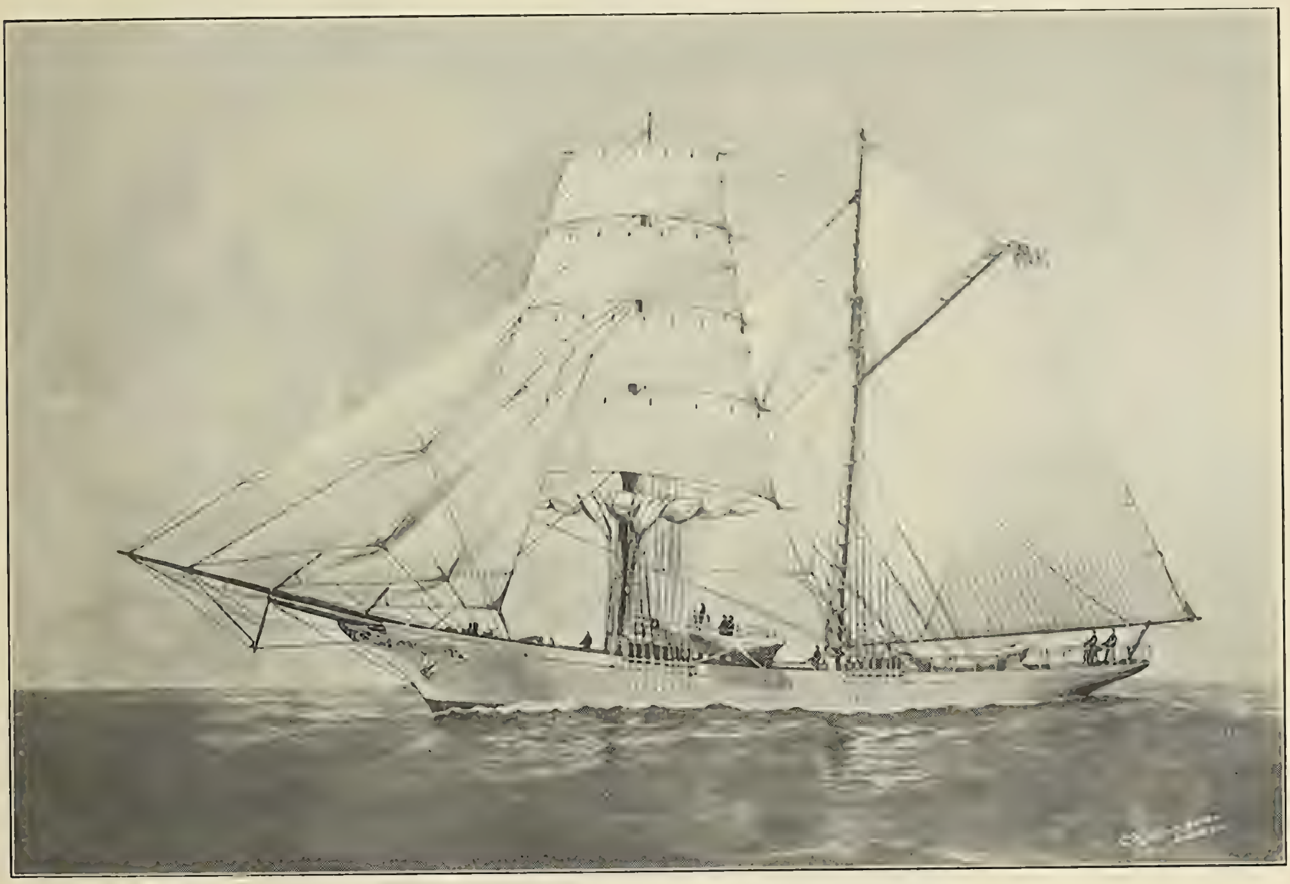

FIG. 1.—THE CARNEGIE AS SHE WILL APPEAR WHEN COMPLETED.

With the experience gained with the *Galilee* it was proved that for the most economical, expeditious and satisfactory execution of this work, it would be advantageous to have constructed a thoroughly non-magnetic yacht with auxiliary power, and every detail arranged especially for making magnetic observations. The building of such a vessel was authorized by the Carnegie Institution, and the matter of design was

placed in the hands of Mr. Henry J. Gielow, naval architect, of New York. The contract for the yacht, which is to be named the *Carnegie,* was placed with the Tebo Yacht Basin Company, of Brooklyn, N. Y., Dec. 9, 1908.

The design of the boat is unusual in two respects: First, since the nature of the work for which she is intended requires that the entire structure shall be practically non-magnetic, she will be the first vessel in the construction of which iron and steel and other magnetic metals will practically have no part; in other words, with the exception of thin cast-iron liners in the cylinders of the bronze internal combustion engine, and the steel cams necessary for operating the valves, aggregating less than 600 pounds, there will be no magnetic materials used in the construction of the vessel. Second, she will be the first vessel of any size and importance in America to be propelled by producer gas.

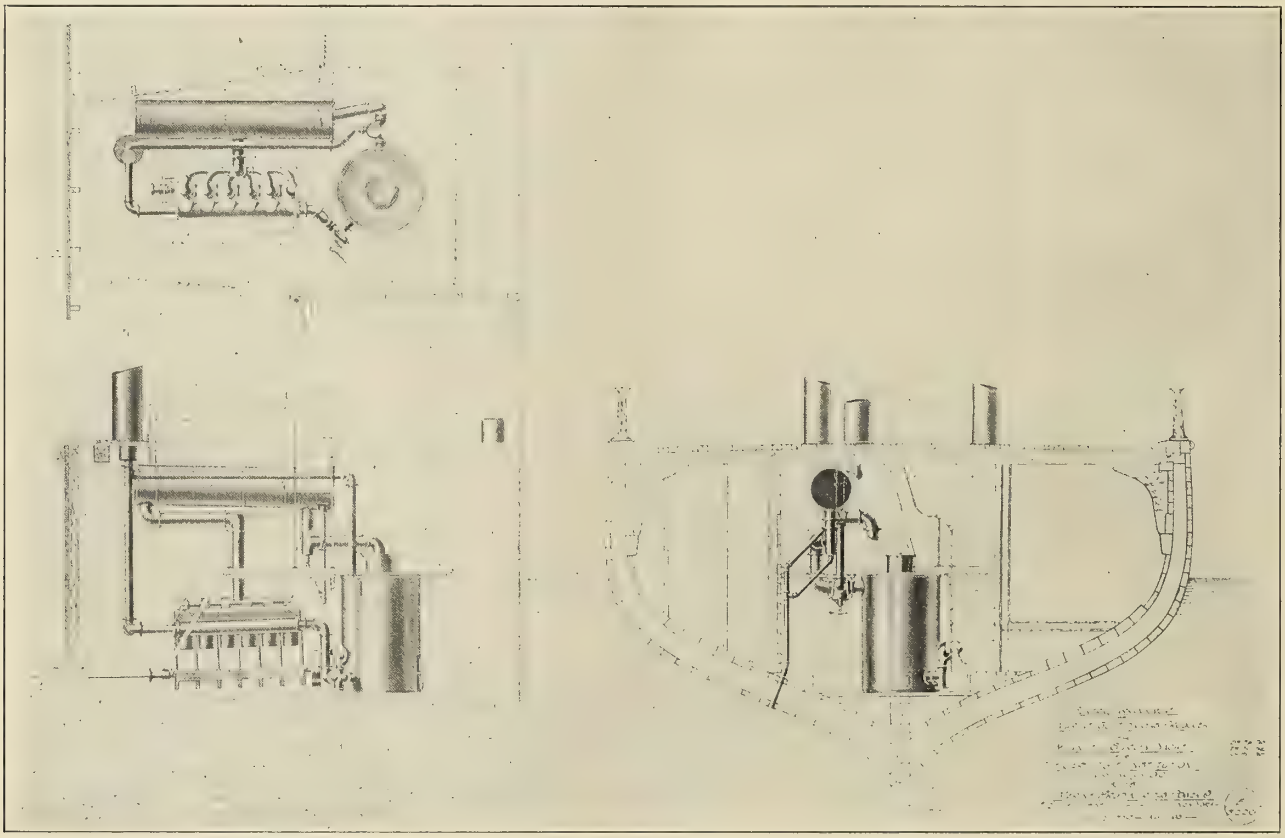

FIG. 2.—SECTIONS THROUGH THE MACHINERY SPACE, SHOWING THE ARRANGEMENT OF THE GAS PRODUCER AND ENGINE.

As the *Carnegie* is intended for ocean surveys, it was decided to build her of the very best materials and make her construction thoroughly substantial, combining the finish and workmanship of a yacht with the sturdy strength of a merchant vessel. Her principal dimensions are as follows: Length over all, 155 feet 6 inches; length on load waterline, 128 feet 4 inches; beam, molded, 33 feet; depth of hold, 12 feet 9 inches; mean draft, 12 feet 7 inches. With all stores and equipment on board, the yacht has a displacement of 568 tons. Her lines are fair and easy, running in an unbroken sweep from stem to stern. In fact, the model shows power and seagoing qualities throughout.

The hull will be constructed as thoroughly and substantially as any merchant vessel afloat, the scantlings being the same as those required by the American Bureau of Shipping for merchant vessels of equal tonnage. The keel, stem, stern post, frames and deadwood will be of white oak; the deck beams, planking and ceiling will be of yellow pine, and the deck of Oregon pine in long lengths, comb-grained. The keel is 12 by 14 inches, and to this is fitted a false keel, 12 inches by 8 inches. There are two center keelsons, each 12 by 14 inches, and two assistant keelsons, 12 by 12 inches. The garboard strakes are 6 by 12 inches, rabbeted into the keel. The planking on the bottom is 3 inches thick; at the bilge 4 inches, and on the sides 3½ inches. The ceiling in the bottom is 3 inches thick, at the bilge 6 inches, and on the sides 4 inches. The main deck beams are 8 by 10 inches, with a crown of 3½ inches at the center of the ship. They are joined to the frames with hackmatack knees with 8-inch siding. The fastenings will consist of locust treenails, copper and Tobin bronze bolts and composition spikes, all through bolts to be riveted over rings, both inside and outside. All metal deck fittings and the metal work on the spars and rigging will be of bronze, copper and gunmetal.

The vessel will have full sail power with a brigantine rig, carrying just under 12,900 square feet of plain sail. Her spar plan measures 122 feet from foremast truck to the water surface, and 201 feet from the forward end of the bowsprit to the aft end of the main boom. The distance from the forward end of the bowsprit to the forward end of the load-waterline is 48 feet; from the forward end of the load-waterline to the foremast 35 feet; from the foremast to the mainmast 48 feet.

The rigging will be of Russian hemp, of special make.

It was decided to install auxiliary power in the yacht, in order to provide headway when taking off-shore observations, where the vessel would be handled with difficulty by the sails, or to prevent interference with the observations by maintaining a headway during calms. The necessity of installing an auxiliary power plant which would be nearly non-magnetic in character, made the selection of the type of this plant a somewhat difficult matter. Steam was precluded on account of the necessarily high magnetic nature of a steam plant. The only

type of prime mover which could be commercially built and maintained in reliable operation with a minimum of non-magnetic metals in its construction, appeared to be an internal combustion engine.

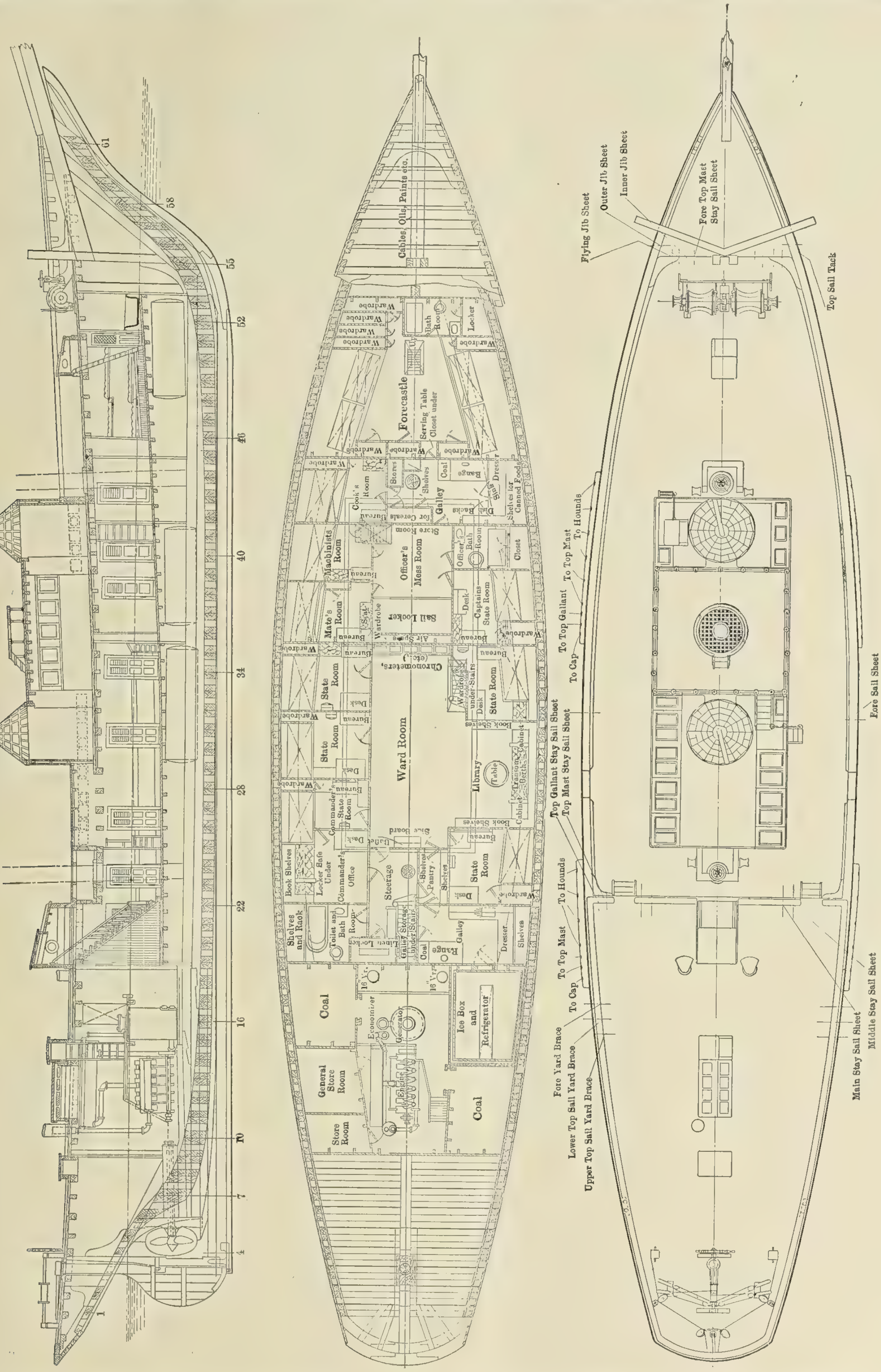

FIG. 3.—INBOARD PROFILE, GENERAL ARRANGEMENT AND DECK PLAN OF THE CARNEGIE.

Consideration of the available fuel for such a motor resulted in the elimination of gasoline or oil, not only on account of cost, but also because they would be absolutely unavailable in the zones to be covered by the *Carnegie*, and dangerous in

the quantities which would have to be stored for the lengthy voyages which are contemplated. It is well known that many thousands of horsepower are being developed with internal combustion engines on land, using gas generated from solid fuels. A careful investigation developed the fact that a marine gas producer could be built which would generate a suitable gas for use in internal combustion engines from bituminous or anthracite coal, coke, wood or charcoal, and that such a plant could be constructed almost entirely of non-magnetic material. The suction type of gas producer was adopted principally for the reason of its simplicity in construction and operation, and the elimination to a minimum degree of other auxiliary apparatus.

The gas producer, which is being built by the Marine Producer Gas Power Company, 2 Rector street, New York, will consist of a cylindrical copper shell, lined with a special grade of firebrick. A shaking grate of manganese steel will be supported in the shell at a suitable distance from the bottom of the generator. This grate will support the fuel bed, and will be accessible through a large cleaning and ashpit door.

after end, and will be drawn, together with the necessary amount of air for its proper combustion, directly into the cylinders on the suction stroke of each of the pistons.

The generator will have a capacity to gasify 160 pounds of anthracite pea coal per hour, producing a fixed, well-cleaned gas, containing 80 percent of the heat units contained in the coal. As provision is made for carrying 25 tons of coal, the yacht will have a cruising radius of about 2,000 miles at a speed of 6 knots.

The engine will be of a type now commonly found in marine service, having six single-acting cylinders. It is designed to develop 150 brake-horsepower at 350 revolutions per minute. The engine will be started by compressed air, which will be stored in copper tanks under 250 pounds pressure. The air will be furnished by a small air pump attached directly to the engine frame. The only alteration in the engine necessary to make it operative on producer gas will be the elimination of the carburetor and the substitution therefor of a gas and air mixing valve, an increase in the size of the inlet valves, ports and piping, and an increase of compression from 70 to 80 pounds per square inch on gasoline to 150 pounds per square inch on producer gas.

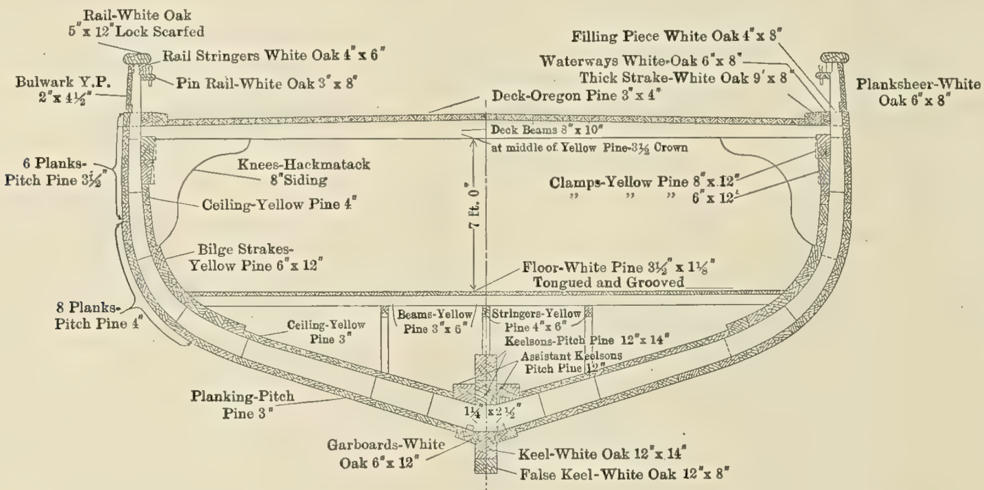

FIG. 4.—MIDSHIP SECTION OF THE CARNEGIE.

The door frames will be riveted to the shell, and will be of non-magnetic metal, as will also the door. The firebrick lining of necessary thickness and quality will extend to the top of the generator.

The generator will be covered with a heavy copper circular plate, at the center of which will be located an improved fuel-charging mechanism. This will be made of manganese bronze. A manganese bronze gas outlet nozzle will be attached to the producer shell at the top. A hand-propelled fan of brass will be attached to the bottom of the generator by means of suitable brass piping and fittings. During a stand-by, or when starting, the gas generated will pass from the outlet nozzle through a special purge valve of manganese steel to an escape vent, which will be of copper, and will communicate with a short copper stack fitted to the main deck at the after end of the engine room.

When the plant is in operation the gas will pass through the purge valve directly into a special cooling and cleansing mechanism, which will be slung fore-and-aft to the under side of the engine room deck beams by means of manganese bronze straps.

Water for cooling and scrubbing the gas will be supplied by a special bronze pump attached to the engine shaft. This water, together with the dirt and ash washed from the gas, will drain from the lowermost point of the scrubber. The scrubber will be made of heavy sheet copper, and all of the fittings and gas piping connecting with it will be of copper or manganese bronze. The gas will leave the scrubber at its

The cylinders, water jackets and heads of the engine will be made of brass. The cylinders will each be fitted with a thin cast-iron liner, to act as a wearing surface for the pistons and rings. Both inlet and exhaust valves will be of bronze, and the latter will be arranged for an internal circulation of cooling water. The wearing surfaces of the pistons will be of cast iron. The cylinders will be mounted on a stanchion-type frame, which will be made of manganese bronze. The engine base, connecting rods, valve stems, igniter box, etc., will also be of manganese bronze. The wrist pins and crank shaft will be made of manganese shaft bronze, a material which has very low magnetic qualities. Any manganese steel used in the construction of the engine will have to be ground to a finish, as it is impossible to machine-tool this material on account of its hardness. The valve cams and rollers will be made of tool steel, hardened and ground. The manganese steel and cast iron, above referred to, will be the only magnetic materials entering into the construction of the engine.

A feathering propeller of special design will be fitted. This will also be constructed of manganese bronze.

The living quarters are all below, ventilation and light being obtained by means of a cabin trunk on the main deck, 42 feet 8 inches in length, 16 feet 6 inches in width and 3 feet in height; heavily constructed of teak wood, finished bright. Skylights, companionway hoods and other wooden deck fittings will all be constructed of teak wood. All hatches will be fitted

with locking devices to secure safety in a seaway. In addition to this the vessel will be sub-divided into seven watertight compartments by means of six transverse bulkheads, so that, with even two compartments stove in, the vessel will still remain afloat.

Immediately aft of the collision bulkhead will be the forecastle, 19 feet 6 inches in length and extending the full width of the vessel, fitted with wardrobes, berths, lockers and ample storage room for eight men. In addition to this there will be a toilet room with bath tub, wash basin, etc., with open, non-magnetic plumbing complete. Immediately aft of the forecastle will be the crew's galley, 8 feet in length by 16 feet athwartships, with range, dresser, sink, shelves, dish rack, bins and storeroom complete. Abreast of the galley, on the port side, will be a double stateroom, with two berths, for the use of the cook and mess man. Aft of the galley and occupying a space of 14 feet 6 inches, will be the officers' mess room, captain's stateroom, mate's stateroom, machinist's room and a toilet and bath room, with bath tub, wash basins, etc., and all plumbing complete. Each stateroom will be fitted with a berth, having drawers underneath, wardrobe and bureau with mirror; the captain's stateroom in addition to this will be fitted with a desk.

Next abaft the officers' quarters are the accommodations for the scientific staff, occupying the full width of the vessel for a length of 38 feet 6 inches; consisting of a ward room 25 feet in length by 11 feet 6 inches in width; three staterooms and the commander's office on the port side, and two staterooms and a library on the starboard side. On the starboard side there will be a mahogany stairway leading to the observation room on deck. In the forward end of the ward room will be a chronometer cabinet and instrument case. Each stateroom will be fitted with a berth with drawers underneath, a large wardrobe, a bureau with mirror, a desk and a folding wash basin, in addition to an upholstered seat with locker underneath. Abaft of the ward room will be the steerage, with a companionway and stairs leading to the deck. On the starboard side will be a galley with all fixtures complete, and on the port side a toilet room with bath tub, wash basin and all plumbing complete. The floor and walls will be tiled. The desks, bureaus, fronts of berths and seats will be of mahogany, finished bright; the doors will be paneled, and, like the bulkheads, will be constructed of white pine, finished in white enamel paint.

Aft of the galley on the starboard side will be an ice-making and refrigerating plant of the ethyl chloride type, constructed throughout of bronze, brass, copper and composition; the whole of sufficient size and capacity to insure a liberal ice supply and ample refrigeration.

Fresh water will be carried in wooden tanks fitted under the cabin and forecastle floor, having a capacity of not less than 6,000 gallons, all properly connected and fitted with piping to all parts of the vessel. The balance of the space under the cabin floor will be arranged in bins and compartments for the storage of various supplies as may be required.

On deck, on top of the cabin trunk, will be the observation room and observatories, consisting of a central observation room, 14 feet 8 inches in length and 16 feet in width, having on each end a circular observatory, 7 feet 8 inches in diameter, each fitted with a revolving dome constructed of bronze framework and plate glass.

The contract calls for the completion of the vessel on or before the first day of July, 1909. Her first voyage will be to the Hudson Bay and the North Atlantic, where very little information of the compass variation has been obtained. This survey will be of great service, because the Canadians, who are opening up the great wheat lands of Western Canada, expect to run a line of steamers through the Hudson Bay from Churchill to Liverpool, a route on which there is open water during the shipping months. After the completion of this work it is expcted that the compass variations along the traversed routes on the Atlantic will be charted.

MARINE ENGINE DESIGN.

BY EDWARD M. BRAGG, S. B.

Calculations.—Make all valves piston valves. Assume eccentricity = $4\frac{1}{4}$ inches; lead upon top end = $\frac{5}{8}$ inch for high-pressure and medium-pressure and $\frac{3}{4}$ inch for low-pressure.

As the design factor used in the first part of the calculations was 0.7, the following steam and exhaust speeds in feet per minute will be used:

Cylinder	High	Medium	Low
Entering steam..........	6,000	7,500	9,000
Exhaust steam..........	5,000	6,000	7,000

Speed of steam through throttle, 5,500 feet per minute.

Speed of steam in exhaust to condenser = 6,500 feet per minute.

The cut-offs obtained in the beginning were *H. P.* = 0.675, *M. P.* = 0.60, *L. P.* = 0.65. When the maximum port opening has been determined, the width of the port can be chosen to give these speeds. The means of the maximum port openings obtained from the diagram, of which only that for the high-pressure is shown (see Fig. 45), are as follows:

High-pressure, $$\frac{2.12'' + 2.24''}{2} = 2.18 \text{ inches.}$$

Medium-pressure, $$\frac{1.84'' + 1.96''}{2} = 1.9 \text{ inches.}$$

Low-pressure, $$\frac{2.25'' + 2.39''}{2} = 2.32 \text{ inches.}$$

When the diagram for the low-pressure cylinder was drawn, it was found that very large valves would have to be used if the eccentricity was to be $4\frac{1}{4}$ inches, so the eccentricity for that cylinder was made $4\frac{3}{4}$ inches.

Width of port for high-pressure,

$$= 2.18'' \times \frac{6{,}000}{5{,}000} = 2.61'' \text{ (use } 2\tfrac{5}{8} \text{ inches).}$$

Width of port for medium-pressure,

$$= 1.9'' \times \frac{7{,}500}{6{,}000} = 2.375'' \text{ (use } 2\tfrac{3}{8} \text{ inches).}$$

Width of port for low-pressure,

$$= 2.32'' \times \frac{9{,}000}{7{,}000} = 2.98'' \text{ (use 3 inches).}$$

High-pressure piston valve,

$$= \frac{(23.5)^2 \times 850 \times 0.333}{5{,}000 \times 2.625} = 11.9'' \text{ (use 12 inches).}$$

Medium-pressure piston valve,

$$= \frac{(41)^2 \times 850 \times 0.333}{6{,}000 \times 2.375} = 33.5'' \text{ (use two of 17 inches).}$$

Low-pressure piston valve,

$$= \frac{(64)^2 \times 850 \times 0.333}{7{,}000 \times 3} = 55.2'' \text{ (use two of } 27\tfrac{1}{2} \text{ inchess).}$$

The port areas for cylinders and areas for exhaust steam through valves are:

High-pressure $= \pi \times 12'' \times 0.75 \times 2.625'' =$ 74 square inches.
Medium-pressure $= \pi \times 34'' \times 0.75 \times 2.5'' =$ 200 square inches.
Low-pressure $= \pi \times 55'' \times 0.75 \times 3'' =$ 389 square inches.

Areas for entering steam are:

High-pressure, $74 \times \dfrac{2.18}{2.625} = 61.5$ square inches.

Medium-pressure, $200 \times \dfrac{2.02}{2.5} = 162$ square inches.

Low-pressure, $389 \times \dfrac{2.21}{2.875} = 299$ square inches.

Throttle valve and main steam pipe:

$$\frac{\pi(23.5)^2 \times 850}{4 \times 5{,}500} = 66 \text{ square inches. Use } 9\tfrac{1}{4}\text{-inch pipe.}$$

Pipe or pipes between high-pressure and medium-pressure valves:

$$\frac{74 + 162}{2} = 118 \text{ square inches. Use } 12\tfrac{1}{4}\text{-inch pipe.}$$

Pipe or pipes between medium-pressure and low-pressure valves:

$$\frac{200 + 299}{2} = 249.5 \text{ square inches. Use } 17\tfrac{3}{4}\text{-inch pipe.}$$

Pipe to condenser from low-pressure cylinder:

$$\frac{\pi(64)^2 \times 850}{4 \times 6{,}500} = 421 \text{ square inches. Use 23-inch pipe.}$$

The data for the valve gear should be collected, and given in some such form as shown in Table VIII. The words top and bottom at the heads of the columns refer to the steam upon the top side and upon the under side of the piston; the quantities given for release and compression are those resulting from the exhaust lap in the same column, the release occurring at one end of the cylinder and the compression at the other end.

TABLE VIII.

	High-Pressure.		Medium-Pressure.		Low-Pressure.	
Eccentricity	4¼ inches		4¼ inches		4¾ inches	
Number and diameter of valves	1—12-inch		2—17-inch		2—27½-inch	
Steam Taken at	Middle.		Middle.		Ends.	
	Top.	Bottom.	Top.	Bottom.	Top.	Bottom.
Width of ports	2⅝″	2⅝″	2⅜″	2⅜″	3″	3″
Steam lap	2⅛″	2″	2 13/32″	2 9/32″	2½″	2⅜″
Exhaust lap	—⅛″	+7/16″	+⅛″	+13/16″	—1/16″	+⅝″
Angle of advance	40° 30′	.....	45° 30′	.....	42° 10′	.....
Steam lead, linear	⅝″	¾″	⅝″	¾″	11/16″	13/16″
Cutoff	0.715	0.635	0.64	0.56	0.69	0.61
Steam release before end of stroke	0.11	0.10	0.11	0.10	0.12	0.11
Steam compression before end of stroke	0.13	0.14	0.13	0.14	0.145	0.155
Maximum port opening	2⅛″	2¼″	1 27/32″	1 31/32″	2¼″	2⅜″
Maximum exhaust opening	2⅝″	2⅝″	2⅜″	2⅜″	3″	3″
Velocity of steam	6,180	5.820	7,750	7,250	9,250	8,750
Velocity of exhaust	5,000	5,000	6,000	6,000	7,000	7,000

The extreme diameters of the cylinder covers are as follows:

High-pressure, $23.5'' + 2 \times 1.125'' + 2 \times 0.75'' + 6 \times 1.25'' = 34.75''$
$34.75'' - 23.5'' = 11.25''$
Medium-pressure $41'' + 11.25'' = 52.25''$
Low-pressure, $64'' + 11.25'' = 75.25''$

The extreme diameters of valve chest covers are as follows: High-pressure piston valve = 12 inches inside diameter. Thickness of liner = 1 inch. The diameter of the hole under the cover = 12 inches + 2 × 1 inch + ½ inch = 14½ inches. Now, $185 \times (14.5)^2 \times 0.7854 = 30{,}500$ pounds. If 1-inch studs are used the pitch circle will be 14½ inches + 3 inches = 17½ inches diameter.

$$\frac{30{,}500}{2{,}060} = 14.8; \text{ use 16 studs.} \qquad \frac{17.5'' \times \pi}{16 \times 1''} = 3.44 \text{ diameters apart.}$$

Cylinder.	Valve Diameter.	Diameter of Stud.	Pitch Circle of Studs.	Number of Studs.	Spacing of Studs in Diameters.
H. P.	12″	1″	17½″	16	3.44
M. P.	17″	1″	22½″	17	4.15
L. P.	27½″	1″	33″	20	5.18

By Formula (51):

High-pressure valve chest cover

$$= 12'' + 2 \times 1'' + 6\tfrac{1}{2}'' = 20\tfrac{1}{2} \text{ inches;}$$
$$20\tfrac{1}{2}'' - 12'' = 8\tfrac{1}{2} \text{ inches.}$$

Medium-pressure valve chest cover

$$= 17'' + 8\tfrac{1}{2}'' = 25\tfrac{1}{2} \text{ inches.}$$

Low-pressure valve chest cover

$$= 27\tfrac{1}{2}'' + 8\tfrac{1}{2}'' = 36 \text{ inches.}$$

The distance between the center lines of the medium-pressure valves, $= y$, should not be less than $1.6 \times 17.0'' + 1'' = 28.25$ inches, nor more than $1.8 \times 17.0 + 2.5 = 33$ inches. It was found best to use $y = 33$ inches, in order to keep the engine as short as possible.

X for the medium-pressure valves

$$= \sqrt{\left(\frac{52.25'' + 25\tfrac{1}{2}''}{2} + 1''\right)^2 - (16\tfrac{1}{2}'')^2} = 36.25'' \text{ nearly.}$$

For the low-pressure valves: $1.6 \times 27.5'' + 1'' = 45$ inches. $1.8 \times 27.5'' + 2.5'' = 52$ inches. Make $y = 45$ inches.

In order that the low-pressure valve cover may clear the covers of the medium-pressure valves by 1 inch, the distance between these valves and the center line of the low-pressure cylinder should be

$$\sqrt{\left(\frac{75.25'' + 25.5''}{2} + 1''\right)^2 - (16\tfrac{1}{2}'')^2} = 48\tfrac{1}{2} \text{ inches, approximately.}$$

The minimum distance between the low-pressure and medium-pressure cylinders will then be 36.25 inches + 48.5 inches = 84.75 inches.

Piston Valves.—Piston valves are made solid, as shown in Fig. 48, or hollow, as shown in Fig. 49. They are made hollow when it is desired to have one pipe supply steam to both ends of the valve, and the area through the middle of the valve should equal the area through the pipe. The length of the valve depends upon the location of the valve liners, which are placed a sufficient distance from the top and bottom of the valve chest to allow the steam to enter and get away from the ends without the area for steam passage being restricted. The liners should be placed as near the ends as possible, and the passageways to the cylinder made as direct as possible, in order to reduce the clearance space. The length of the liners should be such that the piston valve rings will not spring out at the extremities of the stroke. The liners should be counterbored at the ends sufficiently to allow the rings to over-travel ¼ inch or more. The length of the piston valve liner = width of port + steam lap + exhaust lap + the travel of the valve.

The valve stems, eccentric rods and links must be designed to take care of the frictional load, the inertia and the weight of the valves. In addition, if a single valve is used with a guide, such as shown in Fig. 50, the stem below the valve must be designed for the bending that may come upon it from the

pull of the drag rods in reversing when the valve is at its lowest point in the stroke.

In the case of the slide valve, the frictional load can be calculated from the area of the surfaces in contact and the unbalanced pressure upon the back of the valve, no allowance being made for any balancing device. The piston valve is not subjected to any load due to unbalanced pressure, but the friction of the rings and the stuffing-box must be allowed for. It is usual to assume that this load is some multiple of the weight of the valve, valve stem, cross-head and block. If this load is taken as three times the weight of the above parts, a reasonable allowance will be made.

The inertia of the valves is calculated upon the assumption of harmonic motion, and the maximum inertia, at the beginning and end of the stroke, is used. The formula which gives this inertia is:

$$F = 0.00002837WRN^2, \tag{52}$$

where W = weight of valve or valves, valve stem, crosshead and block, usually for the low-pressure gear;
R = length of crank, or eccentricity in inches;
and N = revolutions per minute.

In the case of piston valves, the load for which the valve stem should be figured will be:

$$L = W(4 + 0.00002837RN^2), \tag{53}$$

if no balance piston is used; and

$$L = W(3 + 0.00002837RN^2), \tag{54}$$

if a balance piston is used.

If balance pistons are used which balance more than the weight the load can be still further decreased.

In the case of slide valves the load upon the valve stems will be:

$$L = pAf + W(1 + 0.00002837RN^2), \tag{55}$$

if no balance piston is used; and

$$L = pAf + 0.00002837WRN^2), \tag{56}$$

if a balance piston is used;
where p = the unbalanced unit pressure upon valve;
A = area exposed to unbalanced pressure;
f = coefficient of friction, usually taken as 0.2;
and W, R and N are as above.

The portion of the valve stem between the valve and the link block in the case of single valves, and between the piston valve and the yoke in the case of twin valves should be figured by means of the piston rod formula; the portion of the stem within the valve should be figured for tension only, as the stem is shouldered down where it enters the valve, and the thrust is carried by this shoulder.

This load L is carried by the links, and when they are at an angle with the horizontal (see Fig. 51) there will be a tendency for the block to slide along the links. As the valve stem is kept from moving by the valve stem guide, this tendency results in a bending moment upon the valve stem, and a reaction in the drag rods to keep the links from moving. The maximum angle that the links make with the horizontal is assumed to be:

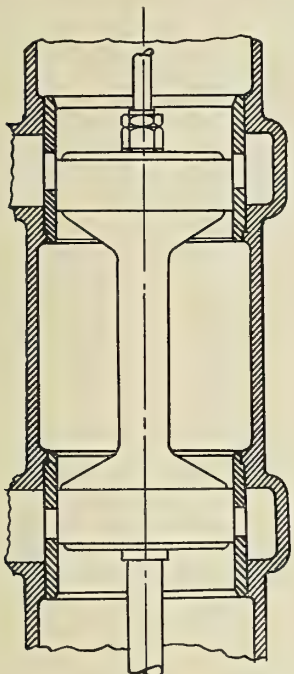

FIG. 48.

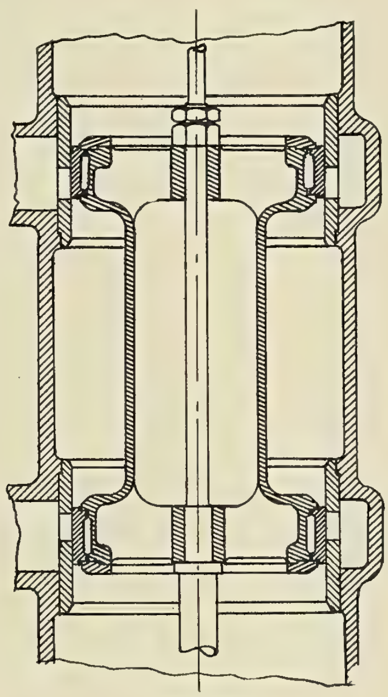

FIG. 49.

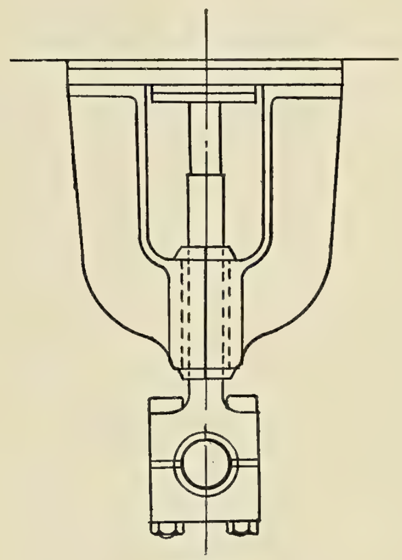

FIG. 50.

$$\sin^{-1} = \frac{2E \sin (90 - d)}{b}, \tag{57}$$

where E = eccentricity of valve;
d = angle of advance; s, u
and b = distance between eccentric rod pinsually = $6E$.

This formula, upon the assumption of $b = 6E$, becomes

$$\sin^{-1} = \frac{\sin (90^\circ - d)}{3}. \tag{58}$$

The component bending the valve stem will be

$$P = \frac{L \sin (90^\circ - d)}{3}, \tag{59}$$

and the bending moment upon the valve stem will be $M = Pl$, where l is the distance from the bottom of the valve stem guide to the lowest point in the travel of the link block. For twin valves, with the stems yoked together, the bending moment would act upon the yoke, which always has plenty of strength.

If the eccentric rod were normal to the link at the time when the latter makes its maximum angle with the horizontal (see Fig. 51) the load P would be all that the drag rods would have to carry; but since the eccentric rod is in line with the valve stem at that time, a portion of the load normal to the links will come upon the drag rods, in addition to the component along the links. In the diagram accompanying Fig. 51,

AO is the load L acting through the valve stem. This load is resolved into BO along the links and AB normal to the links. Since the eccentric rod is in the position OD, the load $OC = AB$, normal to the links, is resolved into CD and OD. The

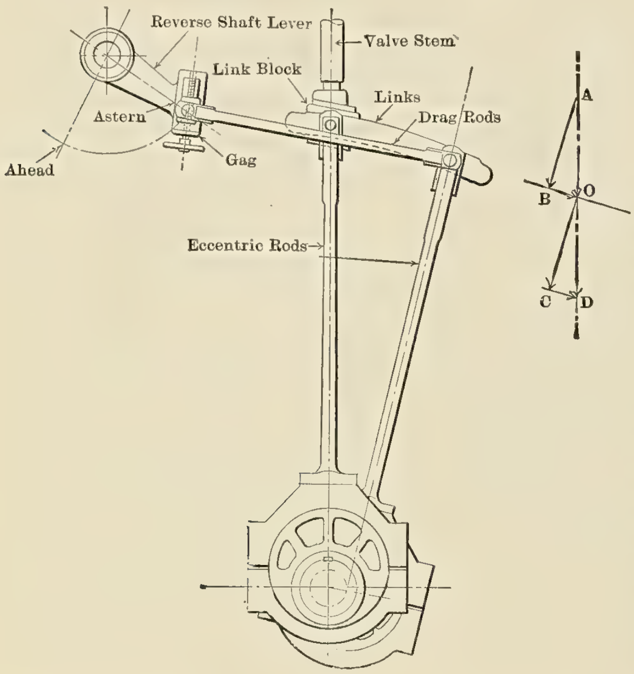

FIG. 51.

drag rods have to take care of $BO + CD = 2P$, and the eccentric rod is subjected to the load L. Although the drag rods are not exactly parallel to the links in the position shown, the load upon the rods will be practically $2P$, so that each rod should be designed for the load P.

(To be Concluded.)

THE HEATING OF MODERN OCEAN LINERS.*

BY W. CARLILE WALLACE.

When we consider that the modern ocean liner has developed into a vast floating hotel, carrying many thousand souls, the importance, from a sanitary standpoint, of effectually ventilating every part of the vessel, and maintaining the passenger accommodation at an equitable temperature, can hardly be over-rated. For vessels of even moderate size, the necessity of some form of mechanical ventilation has proved to be a necessity, as only by that means is it possible to insure a rapid change of air throughout the passenger and crew accommodation, in all kinds of weather.

On the modern ocean liner, the higher-priced state rooms and suites are occupied much more during the day than was the case when the state rooms were only 6 by 7-foot boxes, with two or four berths in them, as the case might be. Passengers are becoming more difficult to please, and competition is becoming keener, so that a shipping company wishing to retain its patrons must equip its vessels with all the luxuries of a modern hotel. As maintaining the individual rooms at an equitable temperature is not the least important of these, I propose, therefore, to restrict the scope of this paper more especially to this problem.

Among the first ocean steamship companies to give the question of ventilation and heating the attention it deserves, the American Line is well to the front, as the *St. Louis* and *St. Paul*, built in 1895, were equipped with a very complete system, consisting of a number of pressure fans, placed on the boat deck, forcing air by means of suitable ducts into the principal state rooms, public rooms and alleyways, the air being warmed by passing over steam-heated coils, suitably arranged close to the fan discharge. Suction fans are also provided and connected to another set of ducts for drawing away the vitiated air from the different rooms. The system has worked fairly satisfactorily as far as the ventilation is concerned, but it has been found impossible to regulate the heat in the state rooms with any degree of certainty.

Leading a double set of ducts throughout the vessel is expensive in first cost, and as space is naturally restricted, the ducts must be kept small; this necessitates an increased velocity of air in the ducts, so as to get a sufficiently rapid change of air in the rooms. As the power to drive these fans increases as the square of the velocity, it becomes apparent that this, together with the increased skin friction consequent on the higher speed of the air, very greatly increases the cost of operation.

A very similar system of ventilation is fitted in the newer vessels of the Red Star Line, the warm air being discharged in these vessels into the public rooms and alleyways on the different decks; and exhaust fans for the removal of the vitiated air being fitted, having ducts leading from the state rooms, these latter being dependent for heat on the warm air from the alleyways being drawn in through venetian panels in the doors to supply the place of the vitiated air drawn out by the exhaust fans. In cold weather, it is found that this system is inadequate to warm the outside rooms, even when the temperature in the alleyways and other parts of the ship is high and the inside rooms much too warm. In summer, with a high outside temperature, this system is worse than useless as a means of cooling the vessel, as observation has shown that the air discharged into the alleyways, etc., by the pressure fans is for several easily-explained reasons from 5 to 10 degrees Fahrenheit above the temperature of the outside air, and as the exhaust fans alone are not of sufficient capacity to ventilate the vessel, there is no alternative in warm weather between having the vessel uncomfortably hot through forcing in fresh heated air, or stuffy and ill ventilated through depending entirely on the exhaust system for ventilation.

To get over these difficulties, numbers of other schemes have been tried, as, for instance, making the ventilation and heating systems more or less independent of each other, the heat in these cases being supplied by individual steam or electric heaters placed in each state room, and more or less under the control of the passengers themselves; the ventilation being affected by exhausting the vitiated air from the rooms and alleyways, the fans and ducts being of sufficient capacity for this purpose, and fresh air entering by storm-proof ventilators, doors or other openings in the passenger accommodation. This system has the advantage of enabling the heat to be regulated without affecting the ventilation in the state rooms, the temperature there being adjusted to suit the varied ideas of the occupants. That this is a matter of no small importance will be vouched for by any chief engineer in the Atlantic service, for should he be so unfortunate as to have an American and an Englishman in state rooms supplied from the same warm-air ducts, he will have a condition of matters which will give him considerably more worry during the voyage than will the main engines.

There are so many manifest objections to placing steam heaters in all the rooms that it is hardly necessary to enumerate them. They are apt to cause an unpleasant smell when first turned on; the multiplication of valves and pipes is a very serious evil, to say nothing of the risk of some of the heaters freezing and bursting while the vessel is lying in port in winter on the American side. On the other hand, electricity lends itself admirably to individual heating at very small initial expense, as every state room is wired for light-

* From a paper presented before the Institution of Naval Architects.

ing, and it only becomes necessary to increase the size of the wires to provide for the extra current.

With the idea of meeting the difficulties already enumerated, and dispensing, if possible, with the individual heating, there has been installed on board the *Lusitania* and the *Mauretania* an elaborate system of heating and ventilation. All this work was carried out by the Thermo-Tank Ventilating Company, Glasgow, and is, I think, without doubt, the best and most thorough scheme so far supplied to any vessel. One special feature which, in the opinion of the writer, will be found of great advantage in warm weather, is the possibility of being able to reverse the direction of the air currents in the ducts, the fans under these conditions exhausting the foul air from the rooms in large quantities, thus causing fresh air to be drawn in through open side-lights, doors, windows, ventilators and other available points.

With regard to the practical working of the system, I believe it has given excellent results as far as the heating and ventilation of the third-class accommodations are concerned, also in the large public rooms, and public open spaces in the passenger accommodation. Unfortunately, from structural and other reasons, it has been found impossible to avoid supplying inside and outside state rooms with warm air from the same thermotank; on that account, I fail to see how it is possible to supply a sufficient quantity of fresh air at the same temperature to insure proper ventilation to both these classes of rooms, at the same time keeping them at the same temperature.

It is only necessary to glance at the plan of the engine and boiler spaces of these vessels to appreciate the enormous the hull. The major portion of the heat, no doubt, escapes by means of the funnel, hatches and engine room and stoke-amount of heat which must be radiated from surfaces inside hold upcast ventilators, but still a larger amount must be conducted through the decks, bulkheads, casings, etc., tending to warm up the interior of the vessel.

For this reason there must be many inside rooms, even as high up as the promenade deck, which will require but a very small amount of additional heat to make them comfortable even in the coldest weather; whereas for the outside rooms on the same deck, with one side, and in some cases two sides, exposed to the weather, a large amount of heat will be required. That this internal heat, so to speak, exists in a vessel, is borne out by observations under all conditions of weather, conducted by Doctor Geissinger, surgeon of the steamship *St. Paul,* from which he found that unoccupied state rooms, depending on their position on the vessel for heat, maintained a certain definite temperature above the outside air during the voyage.

From a careful analysis of the different systems of heating, the conclusion is obvious that the one best adapted to large passenger steamers is a combination of a system similar to that fitted on board the *Lusitania* and *Mauretania,* supplemented by a system of individual electrical heating, the whole combination being under automatic control. Until very recently, there has been no reliable automatic device for regulating the temperature of a room warmed by an electric heater. Numbers of electrical thermostats have been patented, but they have all failed under the test of practical application, and whatever possible success they may have attained on land, they were absolutely useless on board a steamship, owing to their sensitiveness to the slightest vibration.

Some years ago the attention of Dr. Geissinger was drawn to the necessity of some means of regulating the temperature in his room on board the *St. Paul,* which was supplied with an electric heater; as he found that if he left the heater on while absent, the room became much too hot in moderate weather; whereas, if turned off, the room became too cold. Any attempt to use existing thermostats was an utter failure, as he at once found that, owing to vibration, the switch controlling the heater would be destroyed in a few hours, and the contact points of the thermostat itself ruined through oxidization. As a final result of his investigations, he has succeeded in constructing and patenting an electrical thermostat which is positive in its action, controls the temperature within one degree Fahrenheit, is absolutely unaffected by vibration, and requires only 2.75 watts for the controlling current.

For use in staterooms, hotel rooms, etc., the instrument is a combination of two thermostats in one case, the one set for the day temperature of, say, 69 degrees Fahrenheit, the other for a night temperature of, say, 64 degrees Fahrenheit, or less, if desired, both temperatures being easily adjustable to suit the requirements of the occupant of the room. The use of a lower night temperature is very desirable from a health point of view, but has also an important bearing on the quantity of current necessary to maintain this lower temperature, as will be seen later. To change from one temperature to another it is necessary only to throw over an electric switch, when the thermostat takes care of the rest. This thermostat has now been in use in the state room of Dr. Geissinger for over two years, with perfect success.

That there is a very important saving in the amount of heating current when properly regulated, and that, in such cases, the cost of electrical heating is moderate, is well shown by the following report of a deduction from a series of observations taken during the east-bound and west-bound trips of the *St. Paul* between Nov. 23 and Dec. 15, 1907.

The surgeon's cabin is an outside room situated on the first covered deck, and is 7 feet 6 inches by 8 feet, and 7 feet 6 inches high. The ceiling of the room is composed of the bare plating and beams of an exposed deck. The outside paneling is entirely uncovered between two frames and, therefore, this area is practically exposed to radiation through the steel hull to the external air. The cabin is provided with a liberal supply of fresh air through a duct and 4 by 4-inch uptake, and the door is arranged with the customary louvre panel. The ventilation, therefore, is quite up to the standard, and, for certain reasons, the incoming air is rarely or slightly heated. For this particular room, the demand on the heat supply is, therefore, certainly as heavy as that of the ordinary promenade deck state rooms. The room is warmed by one of the regular electric heaters manufactured by the Consolidated Car Heating Company of New York, which consumes 8 amperes at a pressure of 110 volts.

For the purpose of observation, the days were divided into periods, viz.: 8 A. M. to 11 P. M. and 11 P. M. to 8 A. M., which in the following data are referred to, respectively, as "Day" and "Night."

During the day the temperature was kept at 69 degrees Fahrenheit and at night at 64 degrees Fahrenheit, by means of a Geissinger electro-thermostat. This was arranged to operate on a switch which controlled the amount of current supplied to the electric heater aforementioned. In the circuit between the switch and the heater was placed a wattmeter, which recorded accurately the amount of current consumed by the heater in keeping the room at the desired temperature. Careful records were taken of the wattmeter readings, as well as the external temperature and that of the incoming air, for both day and night periods. Summing up the observations taken, the following results were obtained:

SUMMARY OF OBSERVATIONS

Voyage No. 151 *East, S. S. St. Paul*

	Day.	Night.
Average external temperature..	47.1°	44.8°
Average temperature of incoming air (ventilation)....	64.3°	64.4°
Actual consumption by wattmeter	31.9 KW. hr.	4.8 KW. hr.

Extra electric energy (consumed by lamps and for resistance)	9.0 KW. hr.	3.4 KW. hr.
Net consumption	40.9 KW. hr.	8.2 KW. hr.
Total for trip........................		49.1 KW. hr.

Voyage No. 152 West, S. S. St. Paul.

	Day.	Night.
Average external temperature..	45.5°	44.7°
Average temperature of incoming air (ventilation)....	64.6°	64.8°
Average temperature of room..	69.°	64.9°
Actual consumption by wattmeter	50.6 KW. hr.	7.1 KW. hr.
Extra electric energy in room (consumed by lamps and resistance)	9.5 KW. hr.	2.5 KW. hr.
Net consumption	60.1 KW. hr.	9.6 KW. hr.
Total for trip........................		69.7 KW. hr.

In reference to the remarkable difference in power used in the day and night periods, it should be stated that the consumption for the night is so much smaller than that of the day, because the actual time of observation is much shorter and also because the amount of heat required to raise the warmth of the room from the night temperature to the day temperature is comparatively large, and naturally it appears in the total reading for the day.

The following observations conducted recently on board the steamship *Oceanic* should be of interest to naval architects, showing, as they do, the average expenditure of electric energy of a typical and purely electrical system of heating where the passenger has complete control of the heaters.

The halls and public rooms of the vessel are heated by means of steam coils, whereas the staterooms on the two upper decks are heated by electric heaters, consuming on an average 1,200 watts per hour each. These rooms, being on the promenade decks, are ventilated by means of ducts, one to each room, having the intake close under the deck in the center of the outside alleyways or promenade, leading from thence into the side of the deck house, down the side of the stateroom behind the casing, and opening to the room through a ported slide just behind the electric heater, which is placed under the sofa. The doors are solid panels, movable louvres being fitted at the top of the room between the beams, and leading into the hallways.

An accurate record was kept of the consumption of current used in heating the staterooms of this vessel during one round voyage.

It is worthy of note here that, though this ship was originally fitted with multiple-circuit heaters and switches, giving medium, low and maximum heat, it was found advisable to substitute simple heaters of maximum capacity; the finer-sized wires of a divided circuit heater frequently burning out and giving trouble. It was also found that the average passenger did not possess sufficient mechanical knowledge to master the graduation of the switch, and was disposed to blame any extremes of temperature on this mechanism.

Anyone who has had sea experience will appreciate the foregoing observation of the mental apathy of passengers of all classes, for if a passenger is to be made comfortable it must be accomplished without effort on his part, and by far the greater number of complaints regarding the heating and ventilating are usually due to the passenger's neglect or inability to help himself to the means of regulation provided in any properly-installed system.

As a means of determining the actual amount of current necessary to maintain a given temperature in the rooms of the *Oceanic* a test was made on Jan. 28, 1908, while the vessel was lying in dock in Southampton, upon a representative room on the shelter deck. This room is 9 by 9 feet by 8 feet 3 inches, with two square ports and one exposed side, the ventilator and heater being as already described. The heater was tested and found to consume 1,045 watts. The external temperatures were 44½ degrees at the beginning and 42 at the end of the test. The room, which had been closed for three days, was found to be at a temperature of 57½ degrees, and by deduction the effect of the internal heat (I) was estimated to be 10 degrees (that is, the room would have been the standard temperature of 70 degrees if the external temperature had been 60 degrees). The heater was run full power until the temperature reached 69½ degrees, when, after several tests, it was found that if the heater was on for a period of two minutes and off three minutes, the temperature remained constant at 69½ degrees. The radiation, expressed in terms of electrical energy, was therefore determined to be 418 watts per hour, when the external temperature was 42 degrees and the internal heat, as already stated, 10, and, for this special room, may be expressed by the equation $W = 24\ (R\text{-}E\text{-}I)$; when W equals watts per hour, R, temperature at which room is to be maintained; E, external temperature, and I, internal heat. It was also found that 520 watts were required to raise the temperature of the room from 64 degrees, the night temperature, to 69 degrees, the day temperature, in addition to the amount radiated.

A curve of theoretical consumption of energy based on the foregoing formula was plotted for the *Oceanic*, with an assumed temperature for rooms of 69 degrees during the day and 64 degrees at night. In view of the large difference between the theoretical and observed consumption of energy, it may be well to consider in what way the conditions at sea may modify the observations of heat dissipation taken in port.

The ventilation of the room, depending as it does on the force and direction of the wind, is no doubt greater at sea than in port, but assuming that an extra amount of air entering the room was 10 cubic feet per minute, the consumption factor would be increased by 4 ($R\text{-}E$), or from 24 to 28, or about 16 percent. On the other hand, the internal heat (I) would be naturally larger with the boilers in full operation. On the steamship *St. Paul*, I has the value of 8 and 12 in port and at sea, respectively. This correction if applied to the *Oceanic* would increase I from 10 to 15 and decrease W by 120, or about 28 percent. The adjoining rooms and hallways would also be at a higher temperature, therefore it seems safe to assume that the estimation of electric energy in port is in excess of the sea requirements.

The records of actual consumption were obtained by running the heaters of the stateroom from one machine the entire voyage and reading the ammeter every two hours; the external temperatures were also taken every two hours.

The steamship *St. Paul*, sailing from both ports three days later, encountered different temperatures, and the consumption as recorded for comparison is correct for these differences, the equation for this vessel being $W = 20\ (R\text{-}E\text{-}I)$ for radiation, and $W = 20\ (R\text{-}A)$ for ventilation, where $I = 12$, and A is the temperature of the incoming air.

In presenting these records, the consumption has been divided by the number of rooms occupied on the trip by passengers. It is obvious that at no time were all the heaters in use, due to the wish of some of the occupants for cold air, and that the reduction to an average of one room is rather unfair to a comparison of a definitely-heated room, however valuable to the engineer as an average daily record of power used.

These records of the *Oceanic* are especially interesting in that they show the consumption of energy in two extreme con-

ditions. On the westbound voyage this ship passed through exceptionally cold weather, as evidenced by the average temperatures 37.6 and 35.8 day and night, whereas in the eastbound passage the average temperatures were 53 and 52.4, temperatures more in keeping with the month of May.

In this connection it is surprising to find such small differences in the consumption of power between the two voyages, proving the statement already made that the average passenger does not use his heater with reason, or even cater to his own comfort in the smallest degree. It will be noticed that the corrected consumption of the steamship *St. Paul* comes into very close agreement with that calculated for the *Oceanic*, and verifies most strongly the basis on which the latter calculations were made.

On the charts of the steamship *St. Paul* the top lines show the temperatures of the room, ventilating air and external air. The room temperatures are shown for convenience as sharply-broken lines, though the change from high to low and the reverse necessarily takes some time. The other temperatures are recorded in curves joining the average for the period and do not show the hourly variations that are actually found in the ventilating air when steam is turned on.

Taking the cost of coal at 1.2 cents (0.6d.) per kilowatt-hour, which is certainly a low estimate, and applying it to the estimated waste of electrical energy, in the case of the *Oceanic* we get for the westbound voyage a loss of $34 and for the eastbound of $52, or on the round voyage, say, $86 (£17-13-5) in heating forty-nine staterooms. For seven round voyages per year, during which heat is certainly advisable, we get a total loss of £123-14-0 ($602) per annum, which might be saved by placing the heaters under automatic control, so that, regardless altogether of the luxury of definite temperatures, the subject becomes a matter of some financial importance.

	West		East	
	"Day."	"Night."	"Day."	"Night."
Oceanic, observed*	812	844	672	644
Oceanic, calculated*	555	375	174	49
St. Paul, corrected* (for comparison only)	536	296	191	...
Apparent waste*	257	469	498	595
Seven days' waste†	27	31.9	52.2	34.5

	West.	East.
Seven days' waste total†	58.9	86.7
Number rooms occupied	48	50
Total waste for ship†	2,827	4,340
Cost at 1.2 cents per unit	$34	$52

Cost of waste for one round voyage, $86 (£17-13-5).

* Watt-hours. † Kilowatt-hours.

THE AUTOMOBILE TORPEDO OF TO-DAY.

BY A. M. HOFFMANN.

The general public has but a very imperfect idea of the advance that has been made in the development of the automobile torpedo within the last few years. For a great many years after Whitehead built the first of these instruments of destruction, they were notoriously unreliable, despite all of the skill and cunning with which they were fabricated. The principal trouble lay in keeping the torpedo on a straight path. Its powers of inflicting damage when it did hit were undeniable, but there was a large margin of painful doubt before the torpedo finished its run; it was just as apt to hit the ship discharging it as it was likely to hit the target toward which it was started. Only a very few years ago, the same sized torpedo was issued generally to all vessels without regard to the different fields of service for those craft; and the largest of the torpedoes was not more than 3.55 metres (13.98 feet) long. To-day, however, the torpedo has grown to a length of fully 5 metres (19.69 feet), and a distinction is made in assigning these weapons to vessels; torpedo boats being fitted with 18-inch torpedoes of very high speed but shorter range, while the heavy-armored ships carry torpedoes of 21 inches diameter of greater effective range but lower speed. This is instructive, inasmuch as it shows an outcropping of the eternal tendency to specialize, class distinctions thus developing even between torpedoes; and it has been suggested that before long we shall see a further differentiation in the form of a particular style of torpedo to be carried

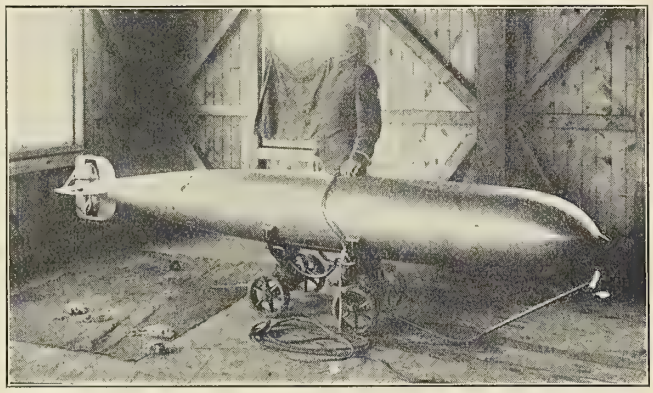

FIG. 1.—THE LATEST TYPE OF 18-INCH TORPEDO.

by submarine boats. In fact, it is believed by some naval experts that the submarine boat will soon prove to be the only practicable craft from which the best of the automobile torpedoes can be fired in order to secure the fullest advantages of the great speed and range now attained by these weapons.

The motive power of the modern torpedo is compressed air. Ten years ago the air flasks of the largest torpedoes were charged to a pressure of 1,350 pounds to the square inch, while to-day the working pressure for the latest types is 2,250 pounds to the square inch; and there is reason to believe that we shall have a further increase as metallurgical advances make it possible to fabricate air flasks of moderate weight which shall be capable of safely withstanding the stress of higher pressures. Pent-up energy of this sort makes the air flask, by itself, a weapon of no mean potentiality. Three years ago, the French battleship *Jaureguiberry* was struck by a torpedo during peace-time practice, and the air flask exploded with sufficient force to crack one of the big propeller struts and cause such leakage around the stern—by reason of damaged plating—as to compel the docking of the ship and incidental repairs, which consumed some weeks. This is significant of the power stored up within these weapons for their self-propulsion.

Until within the past year or two, the range and speed of the torpedo were limited by the initial capacity of the air flask; and the pressure in the flask began to lessen, of course, from the first moment air was permitted to pass to the driving engines, and it did not seem possible to mend matters in that direction. At this point, however, American ingenuity came to the front and devised a means of increasing the motive capacity of the initial air supply by causing its expansion through heat skillfully applied. This was a courageous undertaking, because, at first blush, there seemed a dangerous menace in the possibility of overheating the air and bursting the flask. However, mechanical cunning overcame this obstacle by causing the pressure in the air flask to automatically regulate the flame which superheated the compressed air, and in this manner the developing pressures were made to balance and control themselves. As a result of this pioneer

work, the first 21-inch torpedoes attained very remarkable results; in fact, the speed was increased nearly 50 percent, while the effective endurance or range at the old speed was more than doubled. Since then, correspondingly good results have been secured with the 18-inch torpedo, and the following table will show directly what the superheater has done:

RANGES OF 18-INCH TORPEDO UNDER BOTH CONDITIONS.*

	Air Unheated. Knots.	Air Heated. Knots.
At 1,000 yards	35	43
At 1,500 yards	30	40
At 2,000 yards	28¼	38
At 3,000 yards	23 to 24	32
At 4,000 yards	18 to 20	28

It may be of interest to know in a general way how this is accomplished. In addition to the air flask charged with the motive force for the torpedo, there are two or three small

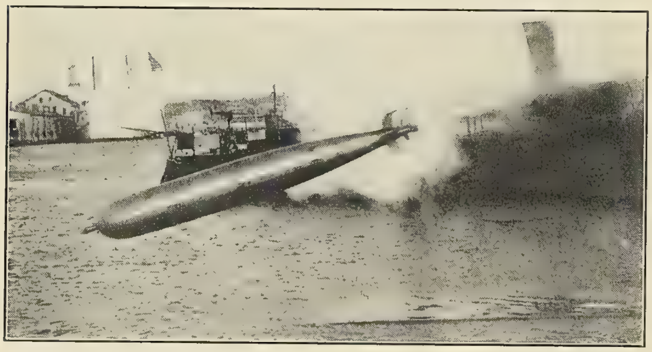

FIG. 2.—DISCHARGE OF A TORPEDO FROM THE DECK OF A TORPEDO BOAT.

flasks which are filled with alcohol and yet retain a little space for a reserve of air. These flasks or tanks are connected to a burner in the big flask or air chamber. When the torpedo is discharged from the torpedo tube the pressure used to expel the weapon—either air or powder—is sufficient to open a little valve which turns on the air to the engines and at the same time opens a connection between the air chamber and the flasks containing alcohol. After the engines have been running a few moments there is a difference between the pressure in the fuel flasks and the pressure in the motive air chamber—the latter being lower. As a result, liquid fuel is forced into the burner in the air chamber and at the same time a cunningly-devised trigger is released which explodes a fuse and ignites the alcohol. Immediately, the heat thus generated causes the air in the chamber to expand and incidentally the working pressure is raised. This pressure, after reaching a point above that in the fuel flasks, restrains the flow of the alcohol automatically until the chamber pressure is again lower than that of the air in the fuel system, the pressure of which is reflexively maintained by the surplus power developed in the main air flask. This added gain in motive force by the use of heat would be of little

* The latest development of the 21-inch torpedo is said to have a range of 7,000 yards.

avail if it were not for the "reducing valve," which stands guard between the air chamber and the engines, permitting air at a uniform speed and a reduced pressure only to be fed to the motive mechanism, in this manner preventing the sudden expulsion of the air and the probable destruction of the engines by reason of the wracking vibrations of too high a rate of revolution. This reducing valve is one of the cleverest features of the modern torpedo, and is automatic.

The Whitehead torpedo, which has followed the American, or Bliss-Leavitt torpedo, in the adaptation of a superheater, works in a different way, the superheater being placed outside of the air chamber and between the "reducing valve" and the motor. As a result, the reducing valve likewise controls the pressure produced by combustion and automatically both the air and the fuel supply, so that it is able to maintain a constant temperature irrespective of the quantity of air or fuel used. The secondary advantage of this arrangement lies in the fact that the air exhausted by the engines is warm and the risk of the formation of ice or frost in the moving parts is eliminated. Under the old condition, where the air was not superheated, the expansion at the exhaust valves was so great that it not infrequently reduced the temperature sometimes to several degrees below zero. This not only produced frosting, but it congealed the lubricant and seriously handicapped the working efficiency of the machinery. In addition to this, the cold water of winter in northern climates helped to this end—it is impossible to run the ordinary cold-air torpedo when the temperature of the water falls to the neighborhood of 40 degrees Fahrenheit, because of the effect upon the initial pressure in the air chamber, and the superheater has thus removed one of the obstacles to effective service in winter time.

Until recently, torpedoes were driven by a wonderfully-compact little engine of the ordinary cylinder or reciprocating order known as the "Brotherhood" balanced type. Although small enough to be housed within a good-sized cheese box, these engines have been able to develop something over 60 horsepower, but the turbine has now supplanted them and added greatly to the speed and to the range of the torpedo by taking up less room. The gain in range has been due to the fact that the motive air is used more economically, while the increase in speed followed because of the fewer moving parts and the incidental reducing of friction.

Until the last few years, the gyroscope installed in torpedoes was spun by a spring which was generally wound a short while before the torpedo was launched. Apart from the shock due to this sudden impulse and the fact that there was thus a limit to the delicacy with which the instrument could be constructed, the gyroscope received no further impulse during the run of the torpedo; as a result there was a gradual lessening of the effective corrective force exerted by the gyroscope or Obry gear, as it was then called. With the introduction of a turbine-driven gyroscope operated by an air impulse, not only was the initial shock due to the spring release done away with—permitting a more finely-balanced device—but the gyroscope was kept in continuous motion by a constant air impulse. The increased smoothness of running due to this modified gyroscope has greatly flattened the path of the torpedo, so that it now travels on a straight line in-

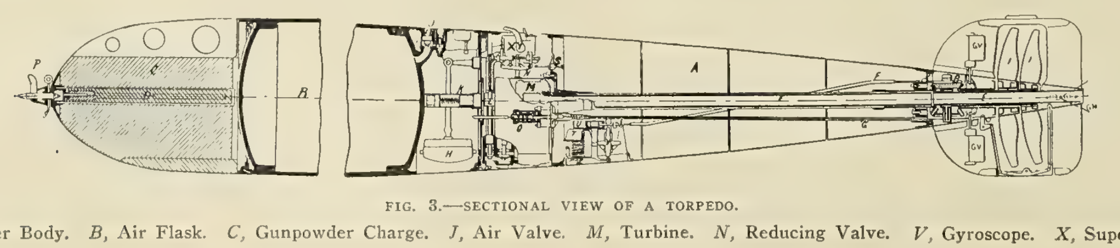

FIG. 3.—SECTIONAL VIEW OF A TORPEDO.

A, After Body. *B*, Air Flask. *C*, Gunpowder Charge. *J*, Air Valve. *M*, Turbine. *N*, Reducing Valve. *V*, Gyroscope. *X*, Superheater.

stead of the very sinuous one of old. This naturally increases the range and the linear speed of the weapon. The balanced turbine for this work is the invention of an American naval officer, and it is a wonderfully cunning piece of mechanism.

The gyroscope is so arranged that it controls the movement of a little motor which, itself, is of sufficient power to move the rudders guiding the torpedo in a horizontal direction. Before the Obry gear was invented, the torpedo was a very uncertain weapon. Dents or other imperfections in the surface of the torpedo used to cause it to steer badly; and if the vessel were moving at the time the torpedo was discharged, and the torpedo struck the water improperly, it was easily "tumbled" and deflected from its desired target. Especially was this so if the torpedo rolled on entering the water so as to cause its horizontal rudders—which normally control depth—to become, pro tem, vertical or lateral rudders. The Obry gear reduced errors due to these causes to a marked extent, but the improved turbine-driven gyroscope of to-day has, in its turn, greatly increased these powers of directive correction.

The gyroscope has been still further widened in its usefulness by making it adjustable, so that the original purpose of holding the torpedo to its line of discharge has been amplified in a manner that now makes it possible to expel the torpedo at an angle of quite 120 degrees from its intended target and yet have the gyroscope bring the torpedo gradually round through that arc and then turn it and hold it in a straight line for its objective. The advantages accruing from this permit of the simultaneous discharge of a torpedo boat's full complement of tubes even though they can not be made to point forward or to bear directly upon the target. All the commander has to do is to adjust the gyroscopes to their proper angles in advance and to point the tubes so that after the torpedoes have described the arcs of these angles they will then point parallel to the fore-and-aft center line of the boat or the direction in which the craft is pointed at the time of their launching. This permits the torpedo boat to approach her target head-on, and thus to offer her most moderate area for the attack of an enemy's gun-fire. When within striking distance, all of the tubes can be discharged simultaneously and with excellent chances of hitting the mark and doing effective work.

It was only a very few years ago that $2,500 would cover the cost of a torpedo; to-day, the prices range all the way from $5,000 to $7,100 apiece. The cost of these torpedoes made the Navy Department reluctant to risk many of these weapons in target practice until the coming of the "soft-nosed" or collapsible-headed torpedo. Torpedoes now fitted with these practice heads can be safely fired against a ship without damaging the vessel or risking the loss of the torpedo, and officers and men are now given the training absolutely needful in order to make them of value in time of war.

The United States naval programme for 1909, as outlined in the Naval Appropriation bill recently reported by the House committee on naval affairs, provides for fifteen new vessels, to cost approximately $29,000,000 (£5,959,000). The bill provides for two 26,000-ton battleships, five torpedo boat destroyers, four submarine boats, one sub-surface torpedo boat and three colliers. The two battleships will be the largest ever laid down by several thousand tons, as their displacement will be 26,000 tons, and it is understood that they will carry twelve 12-inch 50-caliber guns in six turrets, all placed on the center line of the ship. Additional expenditures will bring the total naval appropriation for the year up to $132,000,000 (£27,140,000), as compared with $123,000,000 (£25,290,000) of the current fiscal year.

PIPING UP A MERCHANT VESSEL FOR STEAM HEAT.

BY ALLAN DALE.

Almost the last work of importance to be started in a shipyard drafting room, and the first to go aboard the vessel after it is launched, is the steam-heating system; and the draftsman who handles this work, unless he is an "old timer" and "right on the job," is on pins and needles while it lasts, for it is one continuous case of rush, with little or no time to think.

The reasons for this are as follows: First, it is quite impossible for the draftsman to locate his coils or radiators until the deck or "joiner plans" are completed and approved and the principal rooms detailed; as otherwise the heaters may foul a berth, a desk, the drawers under the berth, the door of a shoe locker, or numerous other things. In fact, the spare room left by the furniture may be so little that no commercial-size radiator can be bought to fit the space, and the furniture will have to be shifted or an especial shape coil be made to fit. Hence, the reason for starting this plan last of all.

Second, it is equally important that the pipe fitters get all their work in place before the polished furniture is installed and before the painters put on the final coat; in fact, before the woodwork is painted at all, as otherwise the scratched or marred surfaces (ruined by the installation of the work) will require refinishing and retouching, which in turn causes needless delay and expense.

Thus it will be seen that once the plans can be started, the work should not only be carried on with the greatest possible speed, but should be so handled that no time is lost anywhere, and that the work in the yard and shop (such as getting out the material and making up the coils) may proceed even while the plans are being submitted for their final approval. To do this certain data should be at hand and a well-mapped routine followed to avoid the many little slips that tie up here and there and cause delay. The information given below, which embodies all this data, is based on years of experience and hard knocks, and no one is apt to go wrong by following it.

STARTING THE PLAN.

The first thing is to procure a plan of the decks—the joiner or arrangement plan—and figure out the square feet of space in each room to be heated, making no allowance for the furniture or lockers that may be in the room. Mark the totals in each corresponding room on the plan as you go along. This done, get the height, deck to deck, and multiply the square feet of each room by this height, marking the total cubic feet in each room underneath the square feet. One height will generally do for all the rooms on one deck. The height may vary, but unless the room be very, very large, this variation will be so slight that it does not affect the size of the heater.

This method will do away with the labor of making out a table or schedule of sizes of rooms, as you have the figures for each room before you, on the plan, in the corresponding room. It also eliminates all chances of error; as you will quickly, by glancing over your plan, detect any figures that may seem out of proportion to the size of room. You are now ready to make up your list of ratios.

RATIOS.

By ratio we mean the proportion of square feet of heating surface in the radiators or coils to the cubic feet of space in each individual room. These ratios vary greatly in different parts of the ship. It should be stipulated very clearly in the specifications what ratios are to be used. Where this is not done (and it is seldom done) the designer should make up a list of these ratios and submit them for approval before he draws in his heaters; unless he cares to run chances of having

his entire plans badly mutilated after everything is finished and shown in ink, for his heaters may be too large or too small, which would not only affect the location of some of them, but would probably change the sizes of steam and drain leads from the engine room manifold throughout the ship and back again to the terminus of the drains, and thus he would have a good share of his work to do over again. This is unnecessary delay in the grossest sense of the word.

The writer knows of no universal standard list of ratios; in fact, it would not be good practice to stick to one such list for all cases, as the designer must be guided by his own judgment. Inside rooms, for instance, do not need as much heat as those having two or three sides exposed to the wind, and an isolated room would need a much higher ratio than one located next to the galley or the boiler hatch. The list given in Table I. can, however, be followed for most cases and a deviation from these figures is advisable only where the ship travels in an exceptionally cold climate.

Table I. Approximate Ratios.

Deck.	Rooms.	Ratio.
Boat	Pilot house	40
	Chart room	75– 80
	Captain's office	75– 80
	Captain's bath	90–100
	Officers' staterooms	75– 80
Promenade	Smoking room	100
	Staterooms	80– 90
	Offices	80– 90
	Toilet rooms	110–115
	Baths	70– 80
Hurricane	Dining saloons	90–100
	Cabins	90–100
	Staterooms	90–100
	Toilet rooms	110–115
	Baths	70– 80
Main	Crew's quarters forward	50– 75
	Staterooms forward	50– 75
	Mess rooms	125
	Staterooms aft	75–100

The pantries, galley, bakery, crew's and firemen's lavatories and showers, and the store rooms are usually not heated directly, since they receive enough heat from other sources. The above ratios are known as "approximate ratios." Before making out the actual ratios it is necessary to say a few words about the sizes and types of heaters.

Standard wall radiators are made by the Fowler & Wolfe Company and by the Pierce, Butler & Pierce Manufacturing Company in the following sizes:

Square Feet of Heating Surface.	Dimensions in Inches.	Thickness in Inches.
$3\frac{3}{4}$	9 x 17	$3\frac{1}{4}$
5	$12\frac{1}{2}$ x 17	$3\frac{1}{4}$
6	$12\frac{1}{2}$ x 21	$3\frac{1}{4}$
7	$12\frac{1}{2}$ x 24	$3\frac{1}{4}$
9	13 x 24	$3\frac{1}{4}$

Other radiators can be had in all styles and sizes up to almost any number of square feet heating surface, but these flat wall radiators are best adapted, for the state rooms at least, as they do not extend more than five inches out when fitted to a wooden bulkhead, and on a steel bulkhead, where no fire protection is needed, they extend out only $3\frac{3}{4}$ inches. They come in either the horizontal or vertical pattern and can be made up in sections of any size. For instance; if 12 square feet of heating surface are required, two 6-foot radiators may be put together, making a section $12\frac{1}{2}$ inches high by 42 inches long, or 25 inches high by 21 inches long, or 21 inches high by 25 inches long, or 42 inches high by $12\frac{1}{2}$ inches long, with only one steam and one drain valve to the entire section. Thus it will be seen that these little radiators readily adapt themselves to any size of wall space, though when used in multiples they should be so ordered from the manufacturers. But we will get to this later on.

These radiators are used in the state rooms and officers' quarters, where appearance counts. For the firemen and crew and steerage quarters it is cheaper to use coils made of 1-inch black or galvanized wrought-iron pipe with return bends, unless specifications state otherwise. The pilot house is generally furnished with brass coils of 1-inch pipe, iron pipe size.

To determine the number of square feet of heating surface in a coil, multiply the outside circumference of the pipe in inches by the length of coil over all in inches by the number of rows of pipes in the coil and divide by 144. Thus: a coil of 1-inch pipe 36 inches long and eleven rows high will have

$$\frac{4.131 \times 36 \times 11}{144} = 11.36 \text{ square feet.}$$

Very frequently the crew's sleeping quarters are so well filled with berths, lockers, etc., that no space is left on the bulkheads or sides for coils. It is then well to install one or more large circular radiators in the middle of the room. These radiators can be bought in halves and fitted around a stanchion if necessary. Such an arrangement works out very well and is also much cheaper than using many coils.

We are now ready to make up our list of radiators, coils and actual ratios. This is done by locating standard size radiators and convenient size coils to scale on the joiner plan, and approaching as near as possible the approximate ratio. This may be done with a soft black or a red pencil, as it is for the draftsman's use only, and as will be seen later, it saves an immense amount of work.

Care should be used in locating the heaters so that they do not come on the outside bulkhead of a cold-storage room, or in the wake of a sliding door, or block a passage. This may seem ridiculous to say, but the writer has seen it done time and again. The number of heaters in a room or passage should also be cut down to as few as possible, as heaters cost money and one large heater will give less trouble than several small ones. Sizes and dimensions of sectional and circular radiators will be found in any manufacturer's catalogue. Steam and drain tappings should be determined from Table III. The list of ratios should be made up similar to the one shown in Table II., which was used on a very recently completed vessel of moderate size. The list made up in this form will give all the information required regarding heaters and will save time in making up the orders in the purchasing department as well as in cutting lengths of pipes for the coils. Note the slight difference between the actual ratios in this list and the approximate ratios in Table I.

This list should now be forwarded for approval.

TRACING THE SHIP WORK.

While the list of radiators, coils and ratios is away for approval, the draftsman should lay down the lines of the ship. This should be done directly on cloth and to any convenient scale, the lines being traced directly from the joiner or arrangement plans. The pilot house and all decks with living spaces should be shown, as well as the holds through which steam or drain leads may pass. Most drawing rooms also require an inboard profile; but the writer does not see the good of this, as the pipes, when several appear in a row, cannot be shown to scale and must be grossly exaggerated. Cross sections would be of much better use and are more appreciated by the men who install the work.

Considerable neatness should be shown in tracing the shipwork, though no waste of time should be allowed. Fine lines only should be used. The frames at the side of the ship need not be shown, but where web frames occur they should be drawn in. Steel bulkheads should be shown in single lines; wooden partitions in double lines. This is to guide the workmen on the ship. All doors and all furniture should be shown, as well as all hatches and ventilators.

Where quarters are paneled, it is well to show it for general convenience, as pipes must be hidden from view in these quarters. The writer finds it good practice to trace in the steering gear leads in fine blue lines and to show the stiffeners on all steel bulkheads, as well as the knee brackets at the sides; also the bulkheads below the deck. The latter may be shown in very fine blue lines that will not show up on the blue print, as they are for the draftsman's use only. They save an immense amount of work in running the drains, as once they are shown in it is not necessary to refer to the steel plans, as would otherwise be the case. Where drawers occur under the berth the draftsman should find out how much space they will occupy and show them in, and make sure that they will clear his heaters.

The writer remembers very well a time when he failed to do this. The heaters were installed very close to the berths and before the drawers were in place. The heaters projected five inches out from the bulkhead, while the drawers would have allowed only four inches. When the joiners tried to get the drawers in place (which was almost at the last minute, before the ship left the yard) the combination would not work and twenty-seven drawers went back to the shop to be cut shorter and practically made over.

Thus it will be seen that too great care cannot be used in showing or indicating everything that may foul the heaters or the leads to and from them. Even the voice tubes and bell pulls should be looked into. It takes but little time to do this in the office and pushes work wonderfully out in the yard, and the draftsman that makes the best showing in this respect is the man that gets promotion.

LOCATING THE HEATERS.

With the ratios approved (we will assume that they have been approved and returned by this time) and the ship work all traced, we now have a clear course and can go at "full speed ahead." So we draw the heaters to scale in every room, simply tracing them from the joiner plan. Most draftsmen mark the size and type of each radiator on the plan as they go along. This is not good practice, as it is extra work and often leads to confusion when changes occur on the plan.

The simplest and quickest way is to simply label the rooms. All necessary information can then be quickly found on the list of radiators, coils and ratios, and when a change occurs in the size of heaters, it is only necessary to change the list; the plan will not be affected at all.

CIRCUITS.

The system is usually divided off into circuits as follows:

Circuit No. 1.—Steam to galley, pantry and sinks and steam and drain to bath-room water heaters.

Circuit No. 2.—Steam and drain to chart room and pilot house, and all rooms on boat deck.

Circuit No. 3.—Steam and drain to first class quarters.

Circuit No. 4.—Steam and drain to second class quarters.

Circuit No. 5.—Steam and drain to steerage and crew's quarters.

The lower deck, being all store rooms and holds, would not require any heat.

Steam to these circuits is supplied through a manifold (Figure 1), which should be located at a very accessible place in the engine room. Steam should be taken from the auxiliary steam line at not more than one hundred pounds pressure. The reducing valve at the manifold will then reduce from one hundred pounds to ten pounds, which is sufficient for the average heating system. The relief valve should be the same size as the steam-supply valve and should be set at about fifteen pounds.

Sizes of pipes and valves may be made up from the following table, which also determines the sizes of steam and drain tappings on the heaters:

TABLE II. RADIATORS—COILS—RATIOS.

DECK.	Room.	Cubic Feet Space.	Ratio.	Number of Heaters.	Type.	Square Feet H. S.	Description.	Steam and Drain.
								Inch.
Boat	Pilot house	825	41	1	Coil	20	11 rows 1-inch brass pipe 64 inches long, over all	½
	Chart room	1,352	75	1	A	18	9 square foot sections, horizontal pattern, 2 high	½
	Captain's office	1,352	75	2	A	9	Vertical pattern	⅜
	Captain's bath	348	92	1	A	3¾	Vertical pattern	⅜
	1st officer	603	80	1	A	7½	3¾ square foot sections, horizontal pattern, 2 high	⅜
	2d and 3d officers	494	82	1	A	6	Vertical pattern	⅜
	Officers' bath	348	92	1	A	3¾	Vertical pattern	⅜
Promenade	Smoking room	4,375	104	1	B	42	45 inches high, 17½ inches long, 9¼ inches wide at base	¾
	Chief engineer	610	87	1	A	7	Vertical pattern	⅜
	Wireless telegrapher	314	84	1	A	3¾	Vertical pattern	⅜
	20 inside staterooms	Approx. 493	82	20	A	6	Vertical pattern	⅜
	16 outside staterooms	Approx. 396	80	16	A	5	Vertical pattern	⅜
	Men's toilet	1,018	113	1	A	9	Vertical pattern	⅜
	Women's toilet	862	115	1	A	7½	3¾ square foot sections, horizontal pattern, 2 high	⅜
	2 bath rooms	252	70	2	A	3¾	Vertical pattern	⅜
Hurricane	1st class dining room	7,896	90	2	B	44	32 inches high, 27½ inches long, 9¼ inches wide at base	¾
	2d class dining room	11,342	90	2	B	63	39 inches high, 30 inches long, 9¼ inches wide at base	¾
	Cabin	5,085	97	2	B	26	39 inches high, 12½ inches long, 9¼ inches wide at base	¼
	26 outside staterooms	412	82	26	A	5	Vertical pattern	⅜
	24 inside staterooms	345	92	24	A	3¾	Vertical pattern	⅜
	2 1st class toilets	968	107	2	A	9	Vertical pattern	⅜
	2 2d class toilets	896	119	2	A	7½	3¾ square foot sections, horizontal pattern, 2 high	⅜
	2 2d class baths	293	78	2	A	3¾	Vertical pattern	⅜
Main	Crew's quarters	2,851	55	1	B	52	Circular	¾
	Quartermasters	896	55	1	B	16	32 inches high, 10 inches long, 9¼ inches wide at base	½
	Waiters	2,570	100	1	B	26	39 inches high, 12½ inches long, 9¼ inches wide at base	½
	Firemen	3,664	125	1	B	30	45 inches high, 12½ inches long, 9¼ inches wide at base	½
	Firemen's mess	638	125	1	Coil	5	9 rows 1-inch pipe 19½ inches long over all	⅜
	Crew's mess	638	125	1	Coil	5	9 rows 1-inch pipe 19½ inches long over all	⅜
	Officers' mess	843	125	1	Coil	7	11 rows 1-inch pipe 22 inches long over all	⅜
	Engineers' bath and watercloset	651	110	1	Coil	6	11 rows 1-inch pipe 19½ inches long over all	⅜
	Cooks	489	100	1	Coil	5	9 rows 1-inch pipe 19½ inches long over all	⅜
	Messmen	489	100	1	Coil	5	9 rows 1-inch pipe 19½ inches long over all	⅜
	Porters	384	100	1	Coil	3¾	7 rows 1-inch pipe 19½ inches long over all	⅜
	1st assistant engineer	493	100	1	Coil	5	9 rows 1-inch pipe 19½ inches long over all	⅜
	2d and 3d assistant engineers	493	100	1	Coil	5	9 rows 1-inch pipe 19½ inches long over all	⅜
	Oilers	618	100	1	Coil	6	11 rows 1-inch pipe 19½ inches long over all	⅜

"A" indicates flat wall radiators. "B" indicates Bundy or Walworth radiators or similar.

TABLE III.

0– 10 square feet heating surface................	$\frac{3}{8}$ inch pipe.
11– 35 square feet heating surface................	$\frac{1}{2}$ inch pipe.
36– 80 square feet heating surface................	$\frac{3}{4}$ inch pipe.
81–175 square feet heating surface................	1 inch pipe.
176–450 square feet heating surface................	$1\frac{1}{4}$ inch pipe.
451 and above	$1\frac{1}{2}$ inch pipe.

This schedule should determine the sizes of all the pipes throughout the ship, the size of reducing valve at the steam manifold and the drain trap. Before running the steam lines it will be necessary to detail the manifold (Figure 1) at

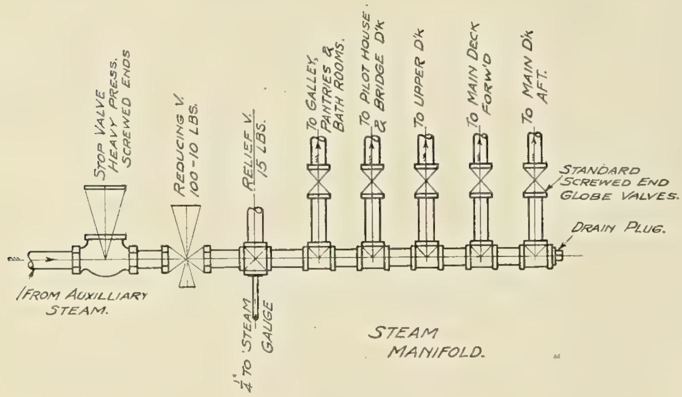

FIG. 1.

about 1-inch scale and locate it so you will have some definite place to start from. As soon as this is done the reducing valve, relief valve and drain trap should be ordered. We are now ready to draw in the pipes, paying no attention to sizes whatever.

Steam pipes should run overhead—drain pipes under the deck, if possible. Care should be used to avoid water pockets. Where such pockets occur, a drain tee must be fitted. All pipes should be perfectly accessible and expansion bends put where necessary. Where pipes pass through steel decks or bulkheads the holes should be carefully located on the plating plan and then shown to scale on the pipe drawing. In doing this it will often be found impossible to get the pipes through where before it seemed an easy matter. A new location must be found and thus trouble is avoided on the ship. In the crew's quarters the overhead pipes should be kept outboard as far as possible, to allow for overhead storage of mess tables and benches. The drain pipes from the after circuits should drain to a manifold in the engine room (Figure 2), and those from the forward circuits to a similar manifold in the boiler room. From these manifolds a single pipe should lead to a trap conveniently located in the engine room, and piped as shown in Figure 3. The discharge from this trap may lead to the feed and filter tank, or as otherwise directed. The writer prefers to connect to the condenser, as it is then possible to open the by-pass valve and suck the entire system clean and dry before laying it up. The drain manifold should be located several feet below the lowest heater and the drain trap below the manifold. The drain pipes from the heaters to the trap should have a steady drop, and where this can not be accomplished, check valves should be fitted to prevent the water from backing up into the heaters.

With the steam and drain lines all shown, the next step is to mark the sizes of pipes. This is done by adding together the square feet of heating surface of all heaters on each branch and obtaining the corresponding size of pipe from Table III.

FINISHING UP THE PLAN.

Everything is now completed except the notes governing the work and a list of reference plans. For the former, each shipyard has its own method and it is hard to give a definite outline. In general, notes may read about as follows:

NOTES FOR HEATING SYSTEM.

Pipes and coils in pilot house to be brass,* all other pipes wrought iron, standard weight, black.* All other coils 1-inch wrought-iron pipe, standard weight, black. Coils fitted with return bends. All heaters tested to two hundred pounds pressure. Valves and manifolds to be* Lunkenheimer regrinding, screwed ends. Valves on radiators and coils to be standard radiator valves, with wooden-rim hand wheels. Brass fittings for brass pipe, cast-iron fittings for wrought pipe. Union

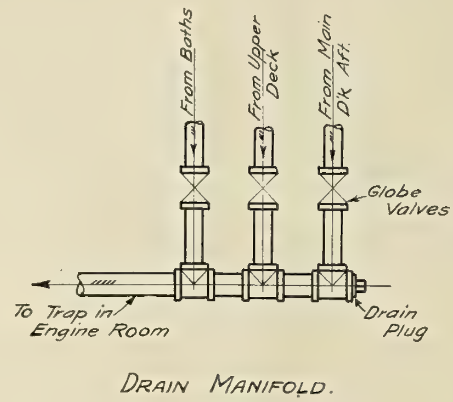

FIG. 2.

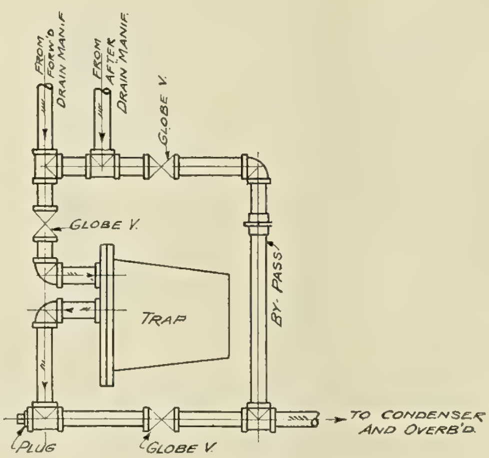

FIG. 3.

couplings to be ground joint. All fittings taken from stock. Heaters to be made up as per list of radiators, coils and ratios.

Reducing valve ordered on requisition number.

Relief valve ordered on requisition number.

Drain trap ordered on requisition number.

Steam gage taken from stock.

Where heaters are secured to woodwork, the same to have a sheet-iron plate fitted one inch from woodwork for fire protection.

Drip pans fitted under radiator valves.

Pipes passing through wooden decks or bulkheads to be thimbled with lead, and where they pass through water-tight decks or bulkheads to be made water-tight.

Leads of pipes and location of heaters are only approximate and must be run to best advantage on the ship.

REFERENCE PLANS.

Arrangement boat and promenade decks.

Arrangement hurricane and main decks.

Arrangement stanchions.

Arrangement steering gear leads.

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* It is assumed that this material is not governed by specifications.

Arrangement drainage and deck piping.
Arrangement ventilation.
Arrangement voice pipes and bell pulls.
Arrangement electric wiring.
Ladders and gratings in engine room.
Ladders and gratings in boiler room.
Piping in engine and boiler rooms, elevation.
Piping in engine and boiler rooms, sections.

The plan is now complete in every detail and may be sent away for final approval. As the list of radiators, coils and ratios is already approved, the standard radiators may be ordered at once, just as they are described on the list. The list contains all the information the manufacturer needs and will do away with all confusion and unnecessary work. Without this list it would be almost impossible to get the heaters to fit. The coils can be made up from this same list in quick time and the piping ordered, and, when the plans are returned approved (or with very slight changes), everything will be ready for installation and there is no possible excuse for delay. There will be no trouble for the draftsman with heaters that are too long or too high, or pipes that foul other work, and the draftsman can work in peace on his next job and forget all about the heating system he has just completed.

THE DEVELOPMENT AND PRESENT STATUS OF THE EXPERIMENTAL MODEL-TOWING BASIN.

BY H. A. EVERETT, S. B.

The Tank at the Yards of Wm. Denny & Bros., Dumbarton.

The oldest private tank in the world, and probably the one with the largest accumulation of merchant ship data in existence, was built upon the suggestion and under the direction of Mr. Wm. Denny, 1882-1884. As may be seen from the cut (Fig. 4), the carriage has a very small span (4 feet) and travels along tracks suspended from the trussed roof. As the carriage is a light wooden one (about 1,100 pounds), with the recording instruments small and compact, the original method of driving the carriage is still retained, which consists of a rope attached to the carriage and wound up on a drum by a steam engine at one end of the tank. Needless to say, it is essential in any tank that is to attempt accurate work that the towing speeds of the carriage must cover an extensive range, and be absolutely constant on each speed. Apparently this especially designed engine gives satisfactory results for a carriage as light as this one, as there is no intention of substituting the electric drive as adopted in the newer stations, and speeds up to 1,200 feet per minute are obtained.

The general method of preparation and material of the models is practically the same in all the European stations, though the length (here 12 feet) varies somewhat, and can be described once for all. The models are of paraffine, toughened by a small amount (1 percent) of beeswax,[8] cast approximately to the form of the hull and finished to exact shape later.

A rectangular tank, larger than the over-all dimensions of the models, is first filled with modeling clay, and by means of molds of the transverse stations or frames, a hollow is scooped out, having the form of the outside of the hull plus the thickness allowed for finishing down. (See Fig. 5.) A core of light wooden strips is made, also to the form of the model, but *smaller* by the thickness the casting is to have, usually from 2 to 3 inches. This core is covered outside with cloth and plastered inside with clay to make it impervious to the hot paraffine. Fig. 5 shows the tank with the mold scooped out and with the core model ready to go in. Next, the core model is suspended in place, and the paraffine run into the space between the core and the mold; at the same time water is filled into the inside of the core to counteract the hydraulic pressure of the paraffiine and to aid in cooling.[9]

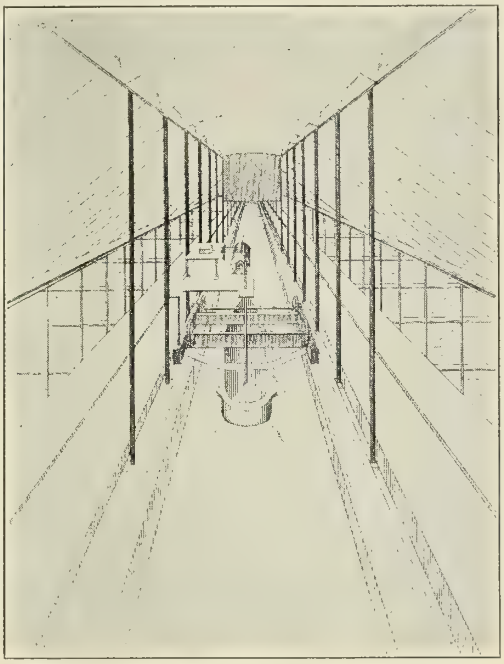


FIG. 4.—INTERIOR OF TANK AT WM. DENNY & BROS.'

When sufficient paraffine has flowed in, the stream is almost entirely shut off. A small amount is still allowed to trickle into the pot hole to make up for loss by shrinkage. When the surface of the paraffine has solidified enough to withstand pressure, the head of paraffine in the pot hole is increased, to provide an automatic supply to balance shrinkage. The model is then left to cool, which takes from 15 to 24 hours, according to size, the core taken out and the top of the model leveled off perfectly flat, the tops of the casting-box sides serving as guides. Wooden members are fitted to the model to strengthen it and provide an attachment for the towing mechanism. A small depression is made on the surface of

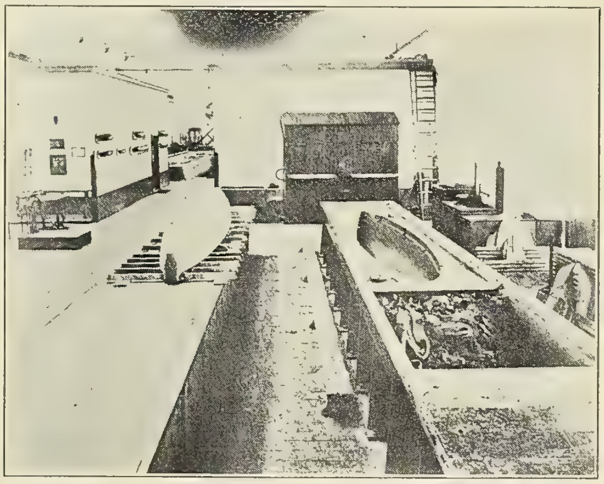


FIG. 5.—CLAY CASTING MOLD WITH FORM SCOOPED OUT AND CORE READY TO GO IN.

[8] Pure paraffine shrinks very considerably on cooling, so that it cracks and tears away from itself. The beeswax minimizes this and makes the casting less brittle and less liable to chip when put through the cutting machine.

[9] The depths of the two liquids are maintained inversely proportional to their densities, to prevent deformation of the core.

the clay next the side of the model, and water is fed into this from a hose, the water percolates between the clay and the model and soon the model is started from its bed by the buoyancy of the water, thus obviating the danger of breakage in starting the model from the mold and permitting ready attachment of the slings for transferring the model to the cutting machine, Fig. 6.

To shape a model accurately it is placed, bottom up, on the bed of a machine in which a pair of revolving cutters, one on each side of the model, cut out on its surface a series of level lines whose contours are precisely similar to the level waterlines on the drawing of the ship whose model is under treatment, Fig. 6. This machine was designed by William

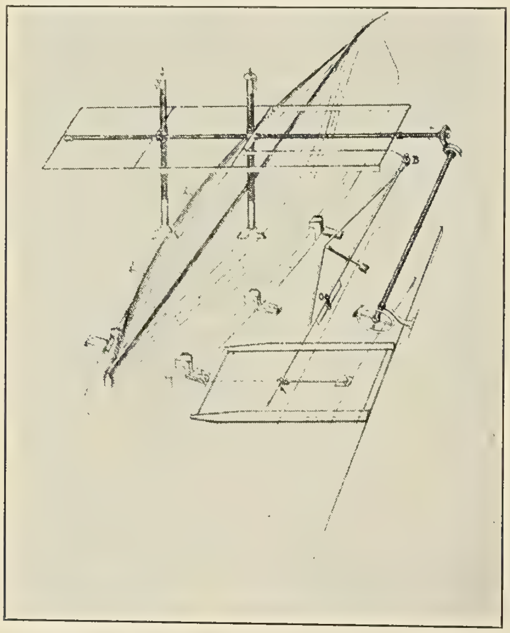


FIG. 6.—DIAGRAM OF FROUDE'S MODEL CUTTING APPARATUS.

Froude, and, with some modifications suggested by his son, is practically in universal use where paraffine is used for models. It is similar to a planer, in that it has a flat bed carrying the model, keel up, moving backward and forward. There are two swiftly revolving (1,500 revolutions per minute) two-blade cutters constrained by a pantograph linkage to move apart or together as guided from the side of the machine. (See Fig. 6.) A tracer disc is offset to this side and has the same transverse movement that the guiding wheel gives to the cutters. A plan of the waterlines on a side table travels back and forth under the tracer disc with the same motion that the model has. It is the duty of the operator to keep the tracer disc in contact with the plan of the waterline being cut, and if he does so the waterline is transformed to the model as the bottom of the groove cut. All the waterlines are cut in this way, beginning at the center and cutting toward the ends. A section through the model, when the machine has finished with it, presents the appearance of a series of steps, the inner angles of which represent the true form. (See Fig. 7.) The waterlines are about ½ inch apart at the bilge to 1 inch apart at the gunwale for a 12-foot model.

The model is then taken from the machine, the excess material, *i. e.*, the paraffine ridges, cut away, the model faired down to the horizontal waterline grooves and finally polished with rags. The details vary in every yard, but the above is the general method.

In the Denny tank at the north end are the general offices, drawing room, molding room (containing the modeling machine and casting boxes), a small machine shop and the finishing room, where the models are brought down to the lines. At either end of the tank are the small docks. The air in the building is heated by hot-water pipes along the sides, and the tank water (fresh) is supplied from the town mains (Dumbarton). All models are made of paraffine, except some light draft paddle boats, which are made of wood.

In the molding room there are two casting boxes large enough to take models up to 20 feet. There are three cast-iron tanks in which the paraffine is melted, the uppermost being used for cleaning the parafine, which has accumulated dirt by melting it with water, which allows the dirt to fall as a sediment, while the clean wax is drawn into the boxes below. Here also is the model-cutting machine. The station is under the direction of Mr. Leslie Denny.

The British Admiralty Tank at Haslar (near Portsmouth).

In 1885, when the land occupied by the Torquay tank was needed for building purposes, a new tank was constructed by the Admiralty at Haslar, near Portsmouth, from the designs of Mr. R. E. Froude, son of Wm. Froude. Mr. R. E. Froude had worked in conjunction with his father in the Torquay tank up to the time of the latter's death, and the new tank embodied the improvements which experience there had shown desirable. The carriage has a span of about 20 feet, and, to give it the necessary rigidity, it is made a built-up girder of wood in the form of hollow boxes cemented and screwed together (Fig. 2 shows it in diagram). It is drawn by a wire rope, wound upon a drum by a steam engine as described for the Denny tank, though there is some thought of applying electric traction. The carriage speeds range from 100 to 800 feet per minute, and an extreme speed of 1,200 feet can be obtained. The models are of paraffine, about 14 feet being the standard length, and an allowance of ¼ inch on thickness is customary for finishing down. When first installed, the longitudinal vibrations of the wire rope proved troublesome, as the car was considerably larger than those previously constructed, but the interposition of a hydraulic cylinder and

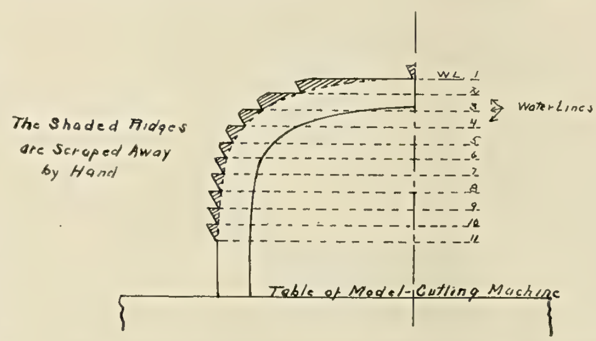


FIG. 7.—CROSS SECTION LEFT BY MODEL CUTTING MACHINE.

piston in the cable eliminated this. Here, as in all tanks using paraffine models, the models are submerged when not in use, to prevent change of form. The basin itself is 400 feet long by 20 feet broad by 9 feet deep, of concrete, and rectangular in cross-section, with a clear run for the carriage of about 360 feet. In addition to the regular model apparatus, a wave-making device has recently been installed in order to investigate the action of ships when propelled among waves. This tank occupies the same position of pre-eminence with regard to warship information and data that Denny's does with regard to merchant work. It is under the direction of Dr. R. E. Froude, and its contributions to the scientific literature of naval architecture, with those of its prototype at Torquay, have probably advanced this branch of science more than any other one thing in the past thirty-five years.

The Tank of the Italian Government at Spezia, Italy.

The Spezia tank, with the two just described (Denny's and the British Admiralty—if we consider the Torquay and its successor at Haslar as one), may be said to constitute the pioneer trio among tanks and the ones having at hand the greatest store of information. As a person's value increases in proportion to his experience, so does that of a well-conducted tank increase with its life. This tank (Fig. 8) was commenced in 1887 upon the recommendation of Mr. S. E. Brin, then Minister of the Marine, and was modeled upon that existing at Haslar, with the consent of the British Admiralty. The tank was completed and began operations in 1889; and though primarily for the Italian Government, it is frequently used for mercantile vessels by the principal Italian shipbuilding firms. The Governments of Austria-Hungary, Portugal and Germany have had naval work done here;

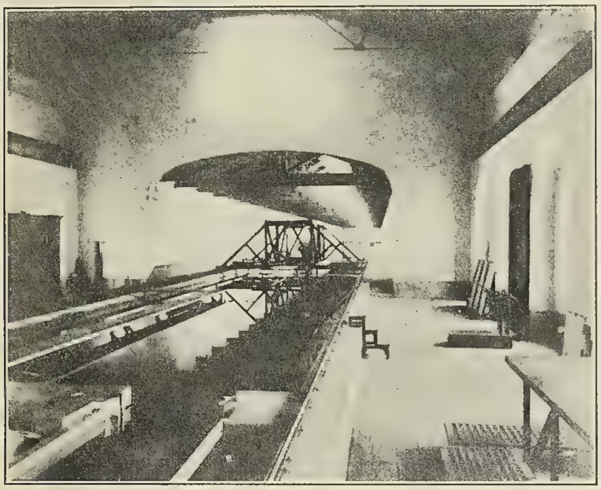


FIG. 8.—INTERIOR OF ITALIAN BASIN AT SPEZIA, ITALY.

though since the latter country has had similar establishments within its own borders it has relied upon its own resources.

The tank proper has a length on the water of 538 feet, with a free tow of 480 feet. It is 19.7 feet broad by 9.9 feet deep, approximately rectangular in cross-section and built of concrete (Plate II.). It has a light wooden roof over it, and the rails for the towing car are laid along the top of the sides of the concrete tank. The carriage, very similar to that at Haslar, is of wood, in the form of two vertical trusses basing on the horizontal frame work that is carried by the four wheels (Figs. 2 and 9); it is 26.25 feet long by 22 feet broad (span) by 7.2 feet high. The apparatus for propeller work is on this carriage, with the hull apparatus, instead of on a separate car coupled to it, as in some of the earlier tanks. The winding engine is stationary at the head of the tank and is controlled from a platform nearby; this is capable of giving the car any speed up to 1,000 feet per minute. The propeller mechanism (Froude's pattern) is capable of testing as high as quadruple screws, and the model propellers themselves are made from large-sized drawings photographically reduced to the desired scale. Wooden patterns are used for casting, instead of the plaster of paris "swept up" mold of the British tanks. This tank, next to that at Washington, has the highest average temperature, single days sometimes as high as 95 degrees F. Vegetable growth in the water gave some trouble until sulphate of copper (1:300000) was tried with entire success. For scumming the surface of the tank, a wooden bridge spanning the tank in a zig-zag line is drawn from end to end. Much of the data of this tank have been published in a book by Lieutenant-Colonel G. Rota, *"La Vasca,"* per *"Le Esperienza di Architettura Navale."*

Tank of the Russian Government near St. Petersburg.

Shortly after the completion of the Italian tank, the Russian Government established one very similar near St. Petersburg, which began operations in 1893. This tank is 440 feet extreme length, with a clear run for the carriage of 374 feet (Plate I.). It is modeled closely after that at Haslar, and is of concrete, with a breadth of 21.8 feet and a depth of 11 feet. The models are of paraffine, 12 feet long, and the carriage for towing spans the tank and travels on rails along the sides. The propeller and resistance apparatus are modeled after those at Torquay and are of the regular Froude type.

United States Government Tank at Washington, D. C.

The tank of the United States Government (Fig. 10) at Washington was completed in 1899 and contains several novel features wherein previous practice has been radically departed from, chief of which are the making of the models of wood instead of paraffine and the increase of the standard model length to 20 feet, the reasons for which will be given later. The tank itself (See Plates I. and II.) is 470 feet long by 42.7 feet wide on the water surface by 14.7 feet deep, and the carriage, which has a span of 47.5 feet, is of steel, the heaviest (70,000 pounds) of any tank yet built." The building over the tank is 500 feet by 50 feet, heated by hot air in winter, and is provided with an automatic device for opening and closing the windows to maintain a constant temperature. The cross-section of the tank (Plate I.) has sloping sides with flat tops, and just below the surface of the water on each side are placed steel troughs about 12 inches square (not shown in the cut) to serve as waves absorbers. The carriage (Fig. 10) is of built-up steel girders, electrically driven by four motors connected to the 30-inch

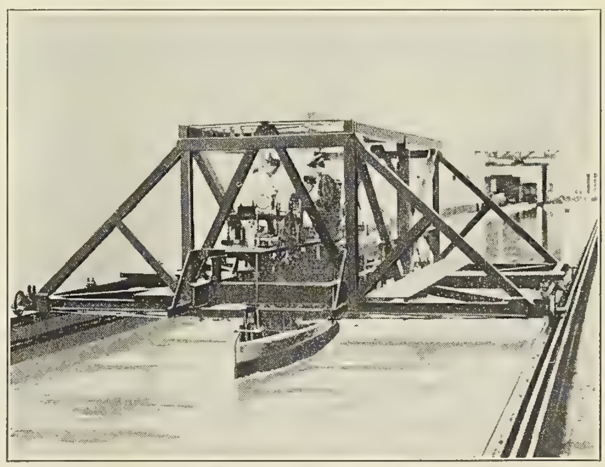


FIG. 9.—TOWING CARRIAGE AT SPEZIA.

driving wheels, and especial pains were taken in the electrical arrangements to secure uniform speed for the carriage. The carriage speeds range from 2 feet to 2,000 feet per minute.

The high temperature prevailing at Washington at certain seasons of the year made the use of paraffine for models out of the question; and after investigation, wood (white pine) was decided upon. Naval Constructor D. W. Taylor, who is in charge of the tank, speaks of the relative advantages and disadvantages as follows (The United States Experimental Model Basin, Proc. Soc. N. A. and M. E., 1900): "Wood retains its shape better. Wood is many times stronger." But "Wood is more difficult and expensive to fashion. Wooden models are harder to keep tight. Wooden models are harder

[10] The carriage was purposely made very heavy, to minimize slight irregularities in speed by the fly-wheel effect its momentum would have.

to give a uniform surface. The first and second objections have been practically overcome by the adoption of special machinery, and the third by using a special varnish to finish the models, which gives a surface practically uniform." The increase of the standard model length was adopted to decrease the gap which the laws of similitude must bridge between the model and the actual ship; and with wood for the model material, 20-foot models could be made amply strong, and the basin and towing carriage are larger than preceding tanks in proportion.

The wooden model is cut from a block built up of white pine lifts about 2 inches thick, glued together (hot) under hydraulic pressure and so proportioned that the minimum thickness of the model, when cut, will not be less than 2 inches. A "former" model (Fig. 12) is built of templates cut to the form of the transverse stations and planked with a skin of strips of wood which has the exact form the model will have. The former model and the block to be cut are placed in the cutting machine (Fig. 14), and the moving of a guide wheel along a transverse station guides the cutting saw along a similar path on the block model. The excess material is knocked away and the cuts brought exactly to form by the substitution of a rotary cutter for the saw. The model is then finished by hand, varnished and measured (Fig. 13), and from these final measurements a body plan is drawn and compared with the original to make sure of its accuracy.

FIG. 10.—INTERIOR OF U. S. GOVERNMENT TANK AT WASHINGTON.

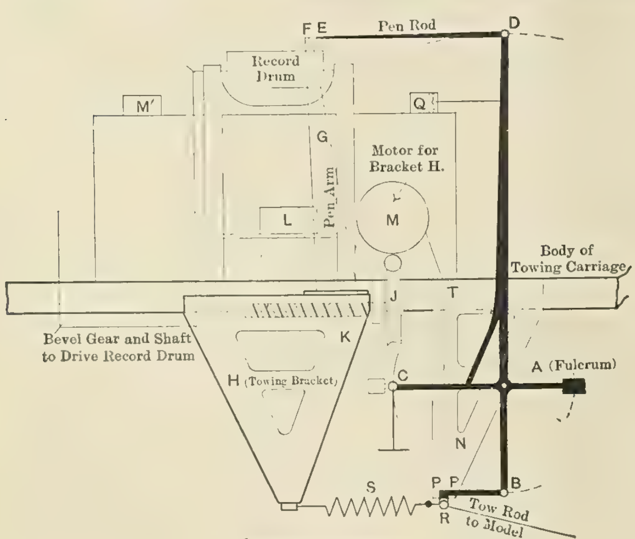


FIG. 11.—DIAGRAM OF APPARATUS FOR RECORDING MODEL RESISTANCE AT WASHINGTON.

The water for the tank is supplied from the Washington city mains and is treated with alum, before entering the tank, to coagulate the mud, after which it passes through sand filters. The capacity of the tank is 1,000,000 gallons; it can be emptied in 4 hours and filled in one week, as the filtering takes considerable time. The tank is scummed by a 4-inch centrifugal pump from the side tanks.

The resistance-recording apparatus on the carriage is quite different from the Froude apparatus previously described. The model is towed from the spring *S* (Fig. 11) attached to the movable bracket *H*, which carries the recording pencil *F* on the arm *G*. The motor *M* automatically forces the bracket *H* forward, when a pull is applied at *R*, until the spring draws the pencil *E* connected to its after end by the linkage *E D A B* back to its initial or zero position; and always the deflection of the spring or its equivalent, the pull of the model, is shown by the distance between the lines drawn on the drum by the two pencils *E* and *F*. The motor moves the bracket *H* by means of a worm and wheel *J*, turning the screw *K*. On either side of the towing cross-head at the after end of the spring are the contacts *P*, and *P*, by which the motor is controlled automatically; and as the distance between them is

slight, the line traced by the pencil E is practically a straight line.

The propeller-recording apparatus is also quite out of the ordinary run and consists of a transmission dynamometer driven by an electric motor for determining the power delivered to the propeller shaft, a traction dynamometer for determining the pull exerted by the propeller, and a revolution counter with a break-circuit chronometer for speed and time records. The first two are carried in a scow-shaped boat, rigidly attached to the towing carriage, and are in line with the propeller shaft.[11]

The Tank at Cornell University, Ithaca, N. Y.

At Cornell University a station of minor importance was established about 1900 by utilizing a section of the canal of the hydraulic laboratory. This tank is 340 feet long by 16 feet wide by 10 feet deep, and is provided with water from the reservoir above through double shut-off gates and an intermediate lock or measuring chamber. The carriage spans the canal and is electrically driven by one 15-horsepower motor at speeds from 100 to 600 feet per minute. Most of the work done here has been with propellers, upon which extensive experiments have been carried out by Prof. Durand. The tank is not roofed over.

(To be continued.)

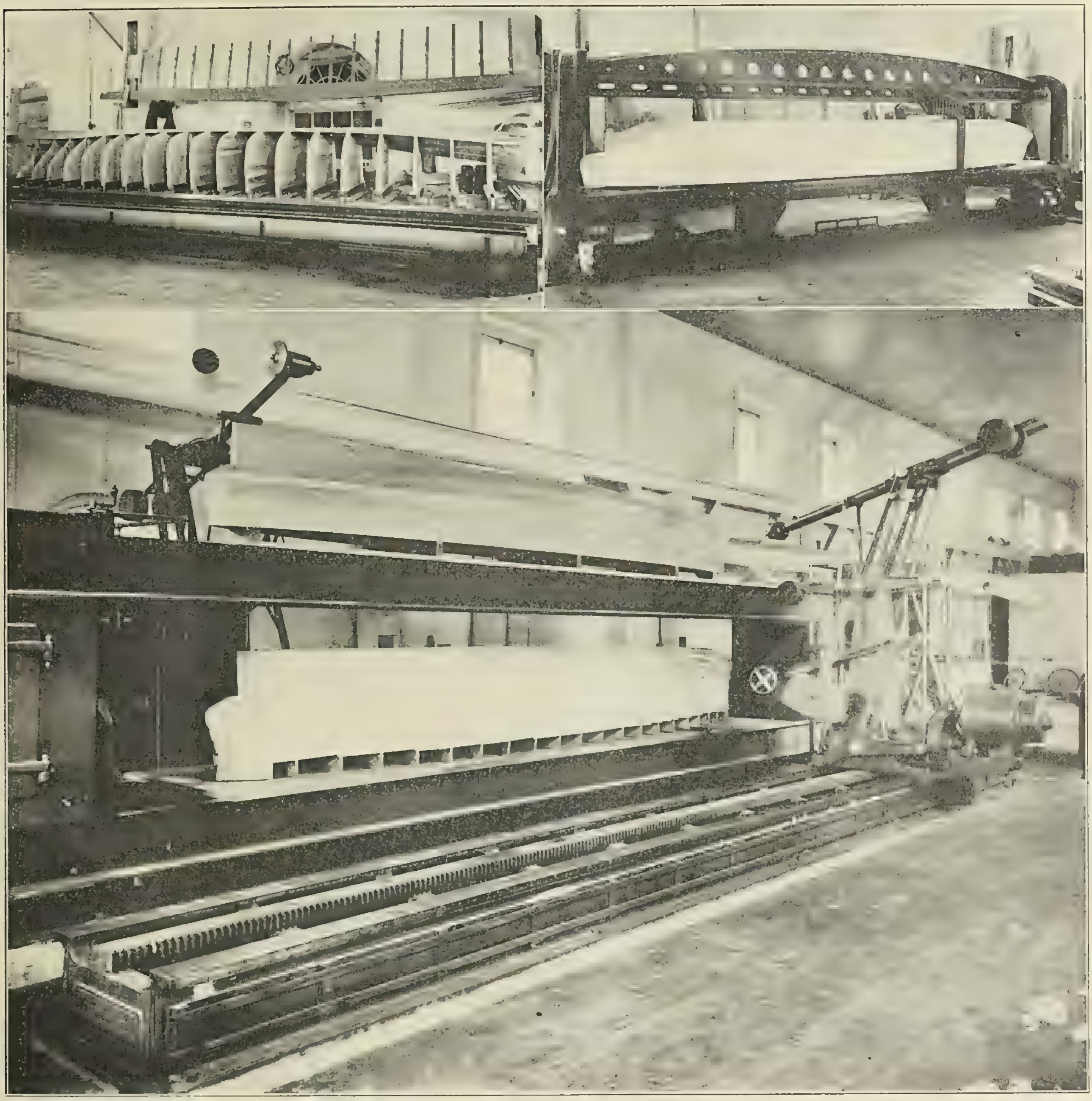


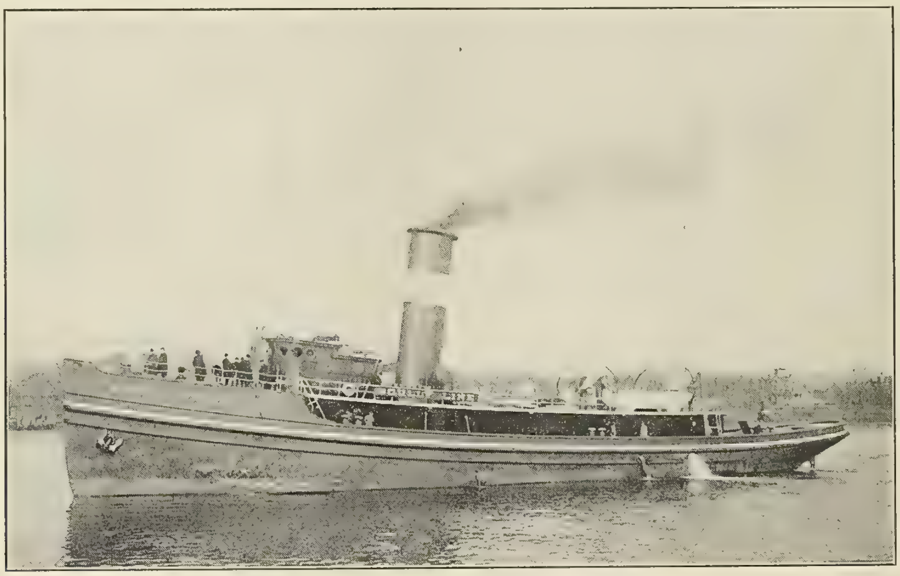
FIG. 12.—"FORMER" MODEL UNDER CONSTRUCTION. FIG. 13.—APPARATUS FOR MEASURING THE FINISHED MODEL.
FIG. 14.—MODEL CUTTING MACHINE, WITH "FORMER" AND MODEL IN POSITION.

[11] For detailed description of this apparatus, see Proc. Soc. N. A. and M. E., 1904, p. 115.

Theoretically, an increase of vacuum from 24 to 28 inches should increase the power developed from 1 pound of steam by about 18 percent. With some types of turbines it is claimed that the actual gain is very nearly equal to the theoretical gain, but in common practice a reduction in the steam consumption of about 17 percent may be expected.

A LARGE SEA-GOING TUG.

With one exception the new steel ocean-going tug *Mary F. Scully,* built and engined by the Staten Island Shipbuilding Company, Port Richmond, N. Y., for Scully's Towing & Transportation Line, New York, is the largest tug afloat. She is 180 feet long over all, with a molded breadth of 30 feet and a depth to the lowest point of sheer of 19 feet 3½ inches. The mean designed draft is 15 feet 9 inches. With a bunker capacity of 500 tons of coal, she has a steaming radius of 5,000 miles. Although built especially for service on the Atlantic coast, she is capable of voyaging to any part of the world without regard to weather conditions. For a distance of 37 feet aft from the stem, the sides of the boat are carried up to the level of the top of the deck house. Thus a forecastle deck is formed, which is a continuation of the upper deck, giving efficient protection for the boat in the heaviest weather. The space thus closed in forward of the deck house is utilized for the windlass, lamp room, paint lockers, stowage of cables, etc.

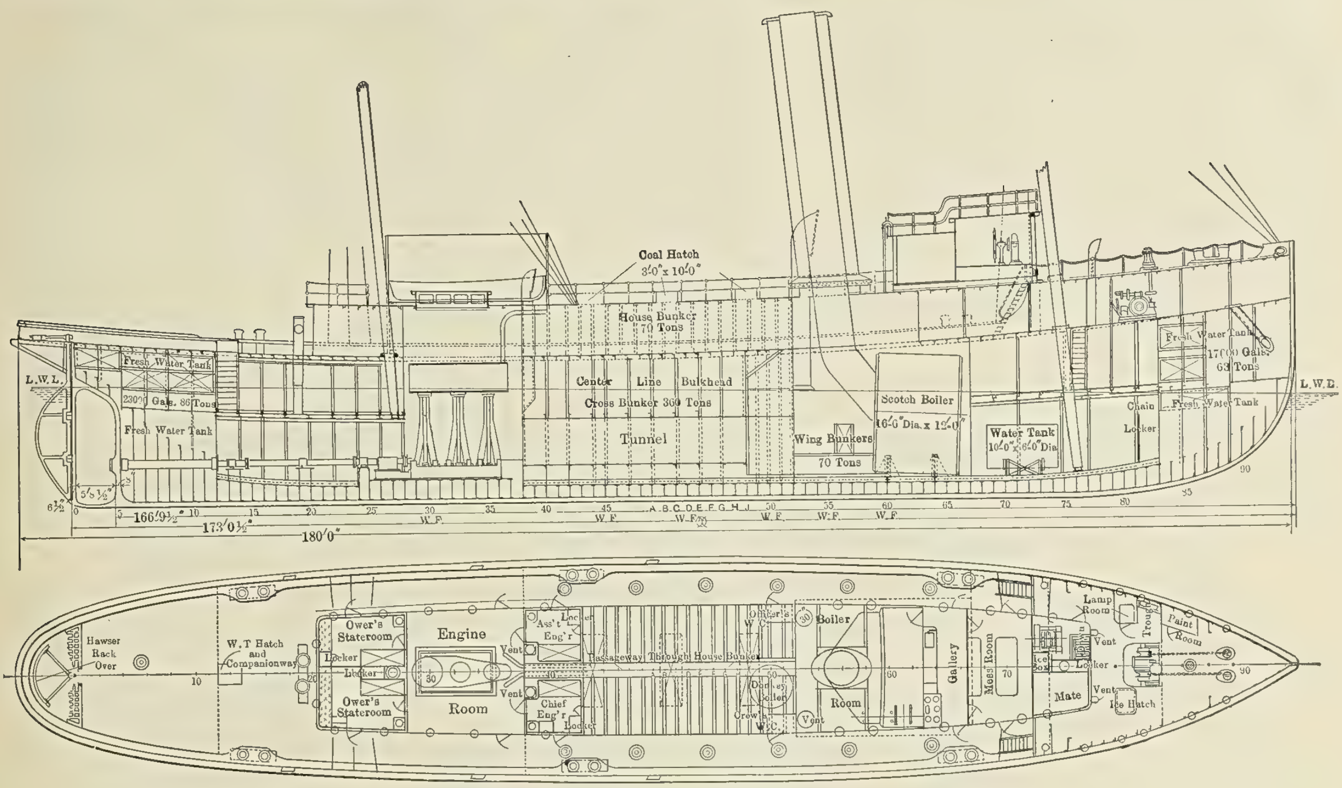


STEEL OCEAN-GOING TUG MARY F. SCULLY.

The hull is built of mild open-hearth steel, and is fitted with bilge keels, consisting of bulb angles 3½ by 9 inches by 22 pounds, reinforced with 3-inch by 3-inch by 7-pound angle-bars. The bar keel is 2 inches by 8 inches, and is fastened directly to the garboard strakes. The frames consist of 3-inch by 4-inch by 8½-pound angle-bars, spaced 20 inches apart throughout the length of the boat. Partial intermediate frames are fitted forward for a distance of 36 feet abaft the stem. The reverse frames extend alternately to 6 inches above the bilge keelsons, and to the under side of the main deck beams. Those in the engine and boiler rooms and coal bunker spaces are doubled from bilge keelson to bilge keelson. Web frames, built of 14-pound plate, 16 inches wide, reinforced on the inner side with double angles, 3 inches by 3 inches by 6 pounds, and secured to the lower deck stringer by diamond plates, 30 inches by 30 inches by 15 pounds, are fitted as follows: Two in the engine room, two in the athwartship coal bunker, and three in the boiler room. The main deck beams are of 3½-inch by 6-inch by 13.4-pound angles amidships, and 3½ inches by 6 inches by 11.6 pounds at the ends. The lower deck beams are 3½-inch by 6-inch by 11.6-pound angle-bars, fitted on every alternate frame. The main deck beams are joined to the shell by 16-pound brackets, 18 by 22 inches, and the lower deck beams are joined to the shell by 16-pound brackets, 18 by 18 inches. The main deck stringer is of 15-pound plate throughout the length of the ship. The lower deck stringer is of 14-pound plate, 16 inches wide, fastened to the shell by 3-inch by 3-inch by 7-pound angles, and reinforced at the inner edge by a 5-inch by 3½-inch by 12-pound angle, and at the inside edge of the frames by the same size angle-bar. Solid floors, 20 inches wide, of 16-pound plate, are fitted on every frame. In addition to a center keelson, built of 15-pound plate, 25 inches wide, reinforced by four angle bars, 4 inches by 4 inches by 9.8 pounds, and a 16-pound rider plate, there are two side keelsons of 16-pound plate, reinforced by double angles above the floors, 3½ inches by 6 inches by 11.6 pounds. The bilge keelsons consist of double angle-bars, 3½ inches by 6 inches by 11.6 pounds.

The general arrangement of the boat provides quarters for the crew on the lower deck forward, and for the stewards and oilers on the lower deck aft. On the main deck forward are the galley and mess room, while the chief engineer and assistant engineer are quartered on the main deck just forward of the engine room. In the after end of the deck house are two spacious staterooms for the owners. The engine and boiler rooms are separated by a large athwartship coal bunker capable of carrying 360 tons. In addition to this there is an additional athwartship coal bunker in the deck house with a capacity of 70 tons, and wing bunkers in the boiler room with an additional capacity of 70 tons. Three coal hatches are provided on top of the deck house, each 10 feet by 3 feet. A tunnel has been built through the deck-house coal bunker, giving a means of communication from the forward to the after part of the deck house. A similar tunnel through the main athwartship coal bunker provides a passageway from the engine room to the boiler room, so that any part of the boat may be reached without the necessity of going out on the deck. This is a feature which has never before been incorporated in a tugboat, and it is one which will undoubtedly prove of great value to the officers and crew, especially in cold and stormy weather.

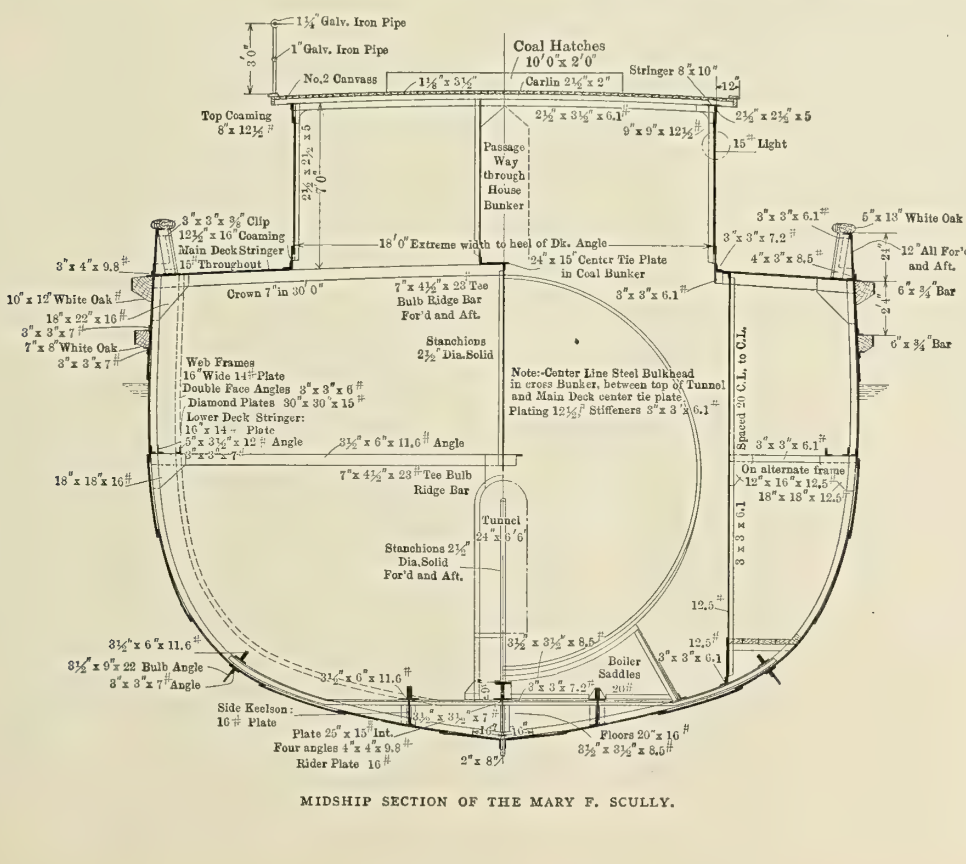
The propelling machinery consists of a three-cylinder, triple-expansion, inverted marine engine, with cylinders 17, 27 and 45 inches in diameter by 36-inch stroke. The high-pressure and intermediate cylinders have piston valves, and the low-pressure cylinder a double-ported slide valve. All valves are operated by Stephenson link motion. The crank shaft is of the built-up type with steel shaft and pins, 9⅜ inches in diameter, and cast steel webs. The thrust shaft is 9 inches in diameter,



INBOARD PROFILE AND GENERAL ARRANGEMENT OF THE MARY F. SCULLY.

with nine thrust collars; the thrust block is of the ordinary horseshoe type. The propeller shaft is 10 inches in diameter, with composition sleeves at the stuffing-box and stern bearings. A sectional propeller wheel, 10 feet 6 inches diameter by 13 feet 9 inches pitch, is fitted, having a cast iron hub and cast steel blades. The main engine is designed for an indicated horsepower of 1,200, to give the boat a maximum speed of 13 knots.

Steam is furnished by one Scotch boiler, 16 feet 6 inches in diameter and 12 feet long. The total heating surface is about 3,695 square feet, and the grate area 101 square feet, making a ratio of heating surface to grate area of 36.5 to 1. The working steam pressure is 180 pounds per square inch. There are four Morison corrugated furnaces, 44 inches inside diameter. Under ordinary conditions the boiler is to be run under natural draft, though, when necessary, forced draft may be



MIDSHIP SECTION OF THE MARY F. SCULLY.

used, as a blower of the Sirocco type, driven by a steam turbine, is provided to furnish air under the grates. The air is heated by being drawn from the upper fire room up between the inner and outer shells of the stack on one side and down on the other side. A division plate between the two stacks directs the air along this path. From the stack the air is forced down around the up-take into the ash pit.

Besides the main boiler there is a donkey boiler, of the vertical tubular type, 68 inches in diameter and 12 feet high, designed for a working pressure of 100 pounds per square inch. This boiler is located in the lower fire room.

The auxiliary pumps are all of the Blake pattern, as follows:

One air pump, 7½ by 15 by 10 inches, vertical, single-acting, twin beam.

Two feed pumps, 8 by 5 by 12 inches, horizontal, simplex piston type.

One fire pump, 12 by 8½ by 10 inches, horizontal, duplex piston type.

One bilge pump, 6 by 4 by 6 inches, horizontal, duplex piston type.

One sanitary pump, 4½ by 3¾ by 4 inches, horizontal, duplex piston type.

The circulator was made by the Staten Island Shipbuilding Company, and is of the centrifugal type, with an 8-inch discharge, direct connected to a 6 by 6-inch engine. The condenser is independent of the engine, and consists of a cylindrical shell containing ¾-inch tubes, with a total cooling surface of 1,600 square feet. A 5 by 5½-inch Williamson combined steam and hand steering engine is located on the main deck under the pilot house. Besides a Hyde No. 3 windlass, there is a Hyde steam gypsy head, operated by an 8 by 8-inch double engine.

The vessel is lighted throughout by electricity, furnished by a 10-kilowatt General Electric generator, direct connected to a single-cylinder engine in the engine room. Besides about ninety-five incandescent lamps, there is an 18-inch Rushmore searchlight installed on top of the pilot house.

The main towing bitts are built of steel tubes about 18 inches in diameter, and extend through the main deck to the lower deck. These are exceptionally heavy in order that the boat may handle the largest tows.

After undergoing her trials successfully the boat was placed in commission, and has made one trip from New York to Norfolk to the complete satisfaction of her builders and owners.

STEAM WHISTLE TROUBLES.

BY DRAZIT.

From time to time we are called upon to face the problem of how to keep the whistle pipe clear of water; and so make that very important unit in a steamer's equipment as efficient

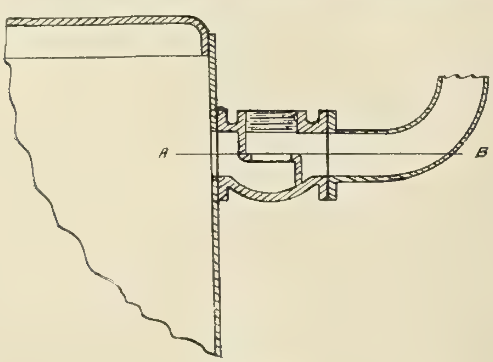


FIG. 1.

as every shipmaster has a right to have it. I suppose nearly all engineers have to deal with this problem at some time or other; and perhaps a few of my own experiences may be useful to some brother engineer who has not been able to solve the problem satisfactorily.

My first experience was in my first ship, and for some time after I joined her it was a case of stand clear when the whistle was blown. The cure was only effected by chance, through taking steam for the steering engine from the whistle pipe, instead of from the auxiliary pipe line, to allow winch steam to be shut off at sea. Since the ship was hard to steer,

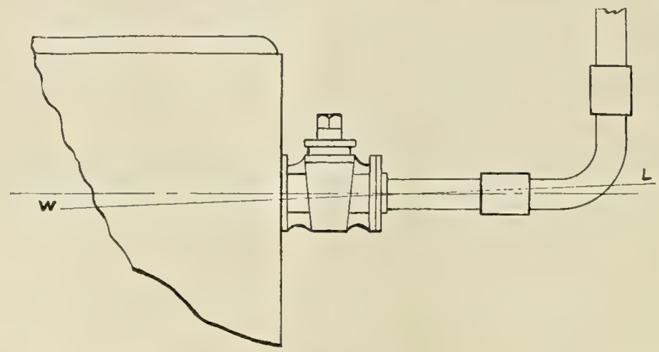


FIG. 2.

the steering engine was kept busy and it in its turn kept the whistle pipe dry.

Case No. 2 was to us a bit of a poser and caused a considerable amount of trouble before it was cured, since with two steamers having practically the same arrangement of piping, etc., one whistle worked with thoroughly dry steam, while the other did not. Both boilers have domes with the whistle pipe connected as shown in Fig. 1, with this difference: the dry-working whistle had a plain plug cock on the boiler end of the pipe, while the wet whistle had a valve; and a good

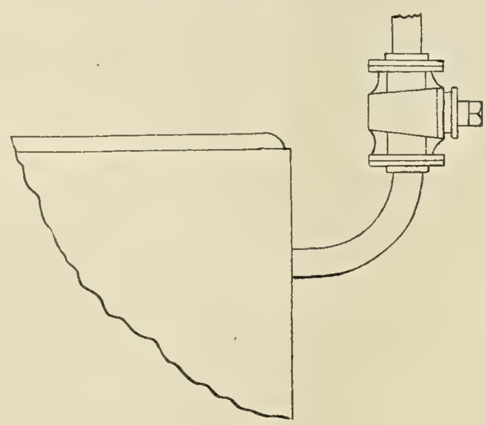


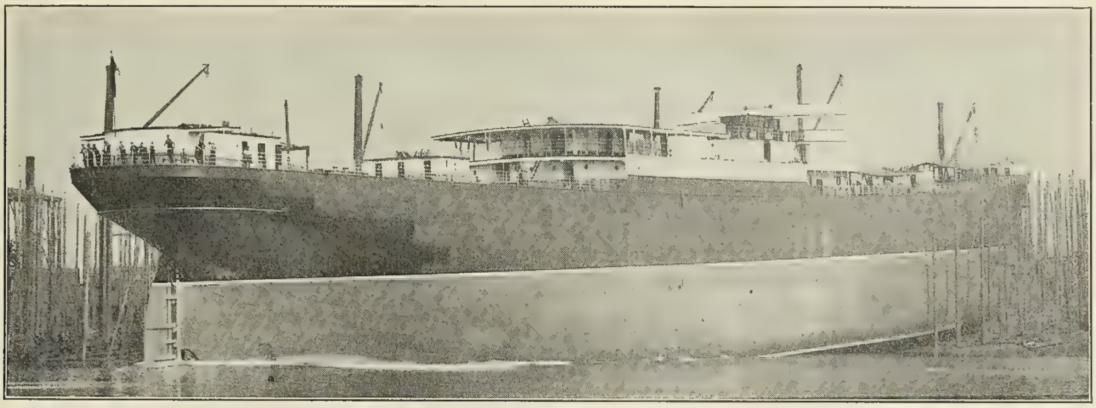
FIG. 3.

deal of experimenting was done before it was decided to try a cock instead of a valve on the wet whistle; and when to the relief of all concerned a cure was effected, we started to hunt round for the cause of the difference. We finally came to the conclusion that with the valve the water of condensation gradually accumulated until a water seal was formed on the line AB, in Fig. 1, the pipe afterwards gradually filling.

Case No. 3 was a very bad one also. The spindle of the valve was made some 3 feet in length, reaching through the top of the deckhouse, so that whistle steam could be shut off from the deck, but of course this did not stop the hot shower when it was necessary to give a blast. In this case also a cock was put on instead of a valve, and although a very great improvement was the result, it was noticed that a small quantity of water came with the first blow. On examination it was found that the horizontal piece of pipe had a dip in it at the

normal trim of the ship, as shown in Fig. 2; and when the bend was opened out and the whole coupled up, as shown in Fig. 3, a complete cure followed.

I do not think a patent drain at, say, midpoint between the whistle and boiler is of any use if the piping and valve on the boiler are not arranged so that water cannot lodge in them. They must drain into the boiler, and in this case the patent drain would not be required. My advice to any reader who has a troublesome whistle is, change your globe valve for a plug cock on the boiler end of the pipe, then see that your pipe has a good fall all the way from the whistle to the boiler, at the usual trim of your ship. With these conditions fulfilled, I think a cure will result.



LAUNCH OF THE OTAKI.

A NEW TYPE OF TURBINE STEAMER.

BY BENJAMIN TAYLOR.

The triple screw steamer *Otaki,* built by Messrs. William Denny & Bros., Dumbarton, for the New Zealand Shipping Company, Ltd., of London, is the first merchant vessel to be equipped with a combination of reciprocating and turbine engines. This arrangement of propelling machinery is not intended for high speeds, but to effect economy in the operation of slow-speed cargo steamships. The idea of securing economy in medium-speed vessels by combining the reciprocating engine with the turbine engine, is the conception of the Hon. C. A. Parsons, of the Parsons Marine Steam Turbine Company, Ltd. The only previous vessel of this type was the destroyer *Velox,* in which reciprocating engines were fitted at the forward end of the turbines, to be connected up when low speed was desired. In the case of the *Otaki,* two sets of reciprocating engines, with cylinders 24½, 39 and 58 inches diameter and a stroke of 39 inches, have been installed, driving the wing screws as in ordinary twin-screw vessels. Between these engines a large-sized low-pressure turbine has been placed, connected to the center screw. The steam is passed first through the reciprocating engines, and then goes to the low-pressure turbine, where the expansion is completed. By this arrangement the high-pressure steam is used in reciprocating engines and low-pressure steam only in the turbine.

The turbine revolves only in one direction, and can, therefore, be used for propulsion only when the vessel is going ahead. Change valves are fitted so that the steam may be passed either directly from the reciprocating engines into the condenser, or to the low-pressure turbine. Thus in maneuvering the vessel becomes an ordinary twin-screw steamer.

The *Otaki* is 464 feet 6 inches long with a breadth of 60 feet and a depth of 34 feet. She is primarily intended for the frozen meat trade from New Zealand, and for this purpose the entire forward part of the vessel in the holds and lower 'tween decks is insulated. One of the 'tween deck spaces is divided into sections and refrigerated by brine pipes, which, under control, enable variations of temperature to be obtained suitable to various classes of perishable cargo. The remainder of the insulated space is cooled by air driven through coil rooms, which are kept at a low temperature by the expansion of compressed ammonia in pipes attached to the bulkheads.

The vessel has five cargo hatchways, each fitted with powerful cargo gear with a great outreach over the ship's side, so that cargo can be discharged direct into the trucks without intermediate handling on the deck. A large steel derrick is fitted at one of the hatches, so that heavy weights can be handled without the necessity of bringing the ship alongside large cranes on shore.

Although not intended primarily for passenger service, the *Otaki* has a Board of Trade passenger certificate, and a few roomy and well-ventilated cabins have been provided for passengers. These accommodations, together with those for the superior officers, are situated on the bridge deck, while those for the junior officers are situated on the deck below.

The *Otaki* is an exact replica of two ships now in service for the New Zealand Shipping Company, Ltd., with the exception of the propelling machinery. Comparing the results obtained on trials of her sister ship, the *Orari,* under similar conditions, an average speed of 15.02 knots was obtained with the *Otaki,* as against 14.6 knots for the *Orari.* At a subsequent trial, the *Otaki* obtained a speed of 15.09 knots. As the boiler installation is precisely the same in both ships, it is considered that this performance demonstrates the advantage of the combined reciprocating and turbine machinery over reciprocating engines.

Based on the results of the trial trips, the speed of the *Otaki* is virtually half a knot greater than that of her two sister ships, and this increased speed is obtained on lower water consumption, which means a correspondingly lower coal consumption. Horsepower in the combined form of machinery is not a very satisfactory measure of useful work, but, assuming that her sister ships had been driven at the same speed on trial as the *Otaki,* and basing the results on the indicated horsepower resulting from this and applying the horsepower to the *Otaki* for her trial trip speed, then the water per horsepower for all purposes would figure out as 12.3 pounds. This result, of course, must be accepted with a certain amount of reserve, as it is based only on the trial data of one of the vessels. Confirmation of this result can only be obtained from actual service on the regular 13,000-mile route of these ships.

The economy of the *Otaki* is due partly to the type of condenser fitted, which enables a high vacuum to be steadily maintained. This condenser is of the "Contraflo" type, from designs by Mr. D. B. Morrison.

A New Reversing Motor for Launches and Yachts.*

The question of reversing internal combustion motors became prominent at the same moment as the application of this type of engine began to be considered for the propulsion of ships, and the problem being particularly fascinating to a number of inventors, has naturally been the source of various patents. The greater part of these inventions have stopped on paper, and those that have taken a more material shape have generally turned out practically inexpedient. Meanwhile boat builders have had to be contented with non-reversible motors provided with different kinds of gearing between the crank shaft and propeller shaft, or with adjustable blades on

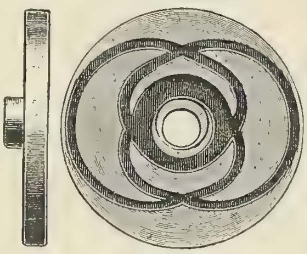


FIG. 1.

the propeller; in the last-named case the propeller shaft itself being non-reversible. We need hardly point out the many difficulties and disadvantages that are inseparable from these methods of solving the reversing problem.

In 1902, Mr. F. G. Ericsson, connected with a small mechanical workshop in Stockholm, patented a direct-reversible motor that attracted much attention. The engine was provided with only one cylinder, designed according to the four-cycle system, to work with gasoline or benzine. The exhaust valve alone was positively governed, and the air inlet-valve opened automatically during the suction stroke, owing to the vacuum that was produced behind the piston. The reversing of this motor was accomplished by igniting the combustible mixture of air and oil-gas at an early stage of the compressing stroke;

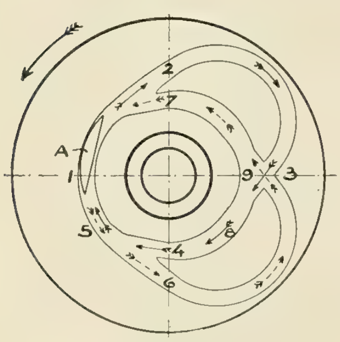


FIG. 2.

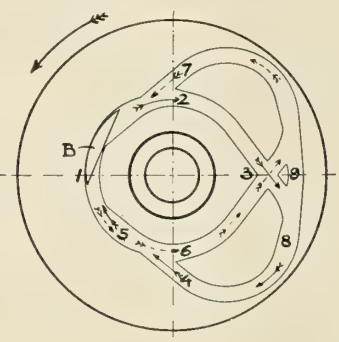


FIG. 3.

the exhaust valve being governed for running the engine "ahead" or "astern" by the aid of a grooved disc keyed to the crank shaft (see Fig. 1). The grooves in this disc guided the movements of a sliding nut attached to the end of a lever that opened the exhaust valve at every other stroke of the piston. Motors provided with this arrangement ran very well, but as they could be built with only one cylinder, much remained to be improved upon in order to obtain an engine for high power.

In 1905 the patents were turned over to a new company, *"Motoraktiebolaget Reversator,"* which resolved to apply the invention to multiple-cylinder motors of the latest design, capable of developing sufficient power for high-speed motor boats and yachts.

Up to date ten different sizes of the "Reversator" motor have been designed and built for utilizing benzine, gasoline or alcohol, varying in power from 3 to 90-brake horsepower, and provided with as many as six cylinders. The new designs are based upon newly-invented improvements on the guiding of the inlet valves as well as of the exhaust valves. The grooved guiding discs are now of a simplified design, and keyed to a separate operating shaft, rotating at half the number of revolutions of the crank shaft.

The improved guiding discs are illustrated in Figs. 2 and 3; Fig. 2 showing the disc belonging to exhaust and Fig. 3 that

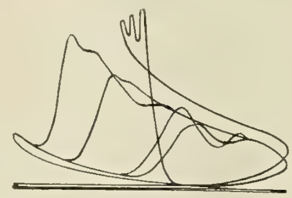


FIG. 4.

belonging to the inlet valve. *A* and *B* represent the sliding pieces pressed against the outer edge of the grooves by means of springs. A revolution of these discs through 90 degrees represents one full stroke of the piston, or half a revolution of the crank shaft.

Supposing the engine to be running "ahead," and the discs to be revolving in the direction of the large arrows in Figs. 2 and 3, the sliding pieces *A* and *B* must follow the grooves along the paths denoted by the full-drawn small arrows. Ignition, combustion and expansion take place from 1 to 2, exhaust of combustion gases from 2 to 3, entrance of fresh air into the cylinder from 3 to 4, compression from 4 to 1, after

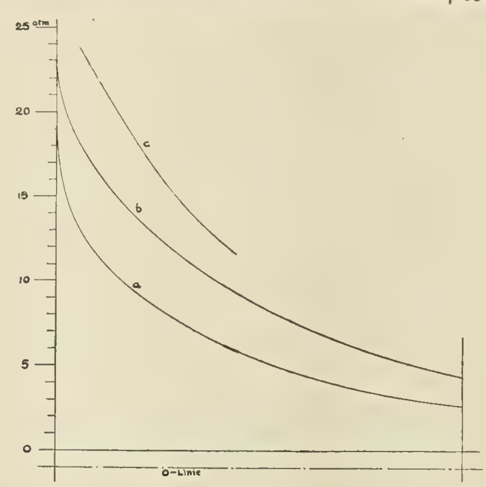


FIG. 5.

which the cycle is repeated in the same order. Now, suppose the direction of revolution to be reversed, which is accomplished by igniting the combustible contents in the cylinder at an early stage during the compressing stroke. The sliding pieces *A* and *B* will at the moment, when reversing commences, be in the position marked 5, and from thence follow the path denoted by the small dotted arrows. Expansion will, under these circumstances, be executed from 5 to 6, exhaust from 6 to 3, entrance of fresh air from 3 to 7, compression from 7 to 1, and ignition followed by combustion and expansion from 1 to 6.

Now, considering the case of a four-cylinder motor, we find that at the moment of reversing, the entrance of fresh air has

* Compiled principally from "Teknisk Tidskrift," journal of the Swedish Society of Engineers and Architects. Supplementary material and illustrations supplied by "Motoraktiebolaget Reversator," Stockholm, Sweden.

just commenced in one of the cylinders, and the sliding pieces controlling the valves of this cylinder are consequently near the position marked 8 in Figs. 2 and 3. After reversing has commenced the sliding pieces will follow the paths 8-9-7, which causes the cycles in this cylinder immediately to become executed in proper order. This is a very important point in the new improvement, and explains why the guiding disc projecting at the bottom of the dial, for the purpose of regulating the speed of the motor. This regulation is accomplished by throttling the admission of combustible gas mixture to the cylinder through the aid of a slender wire connected to the maneuvering pedestal, which, consequently, may be fixed in any convenient place in the boat independently of the position of the motor.

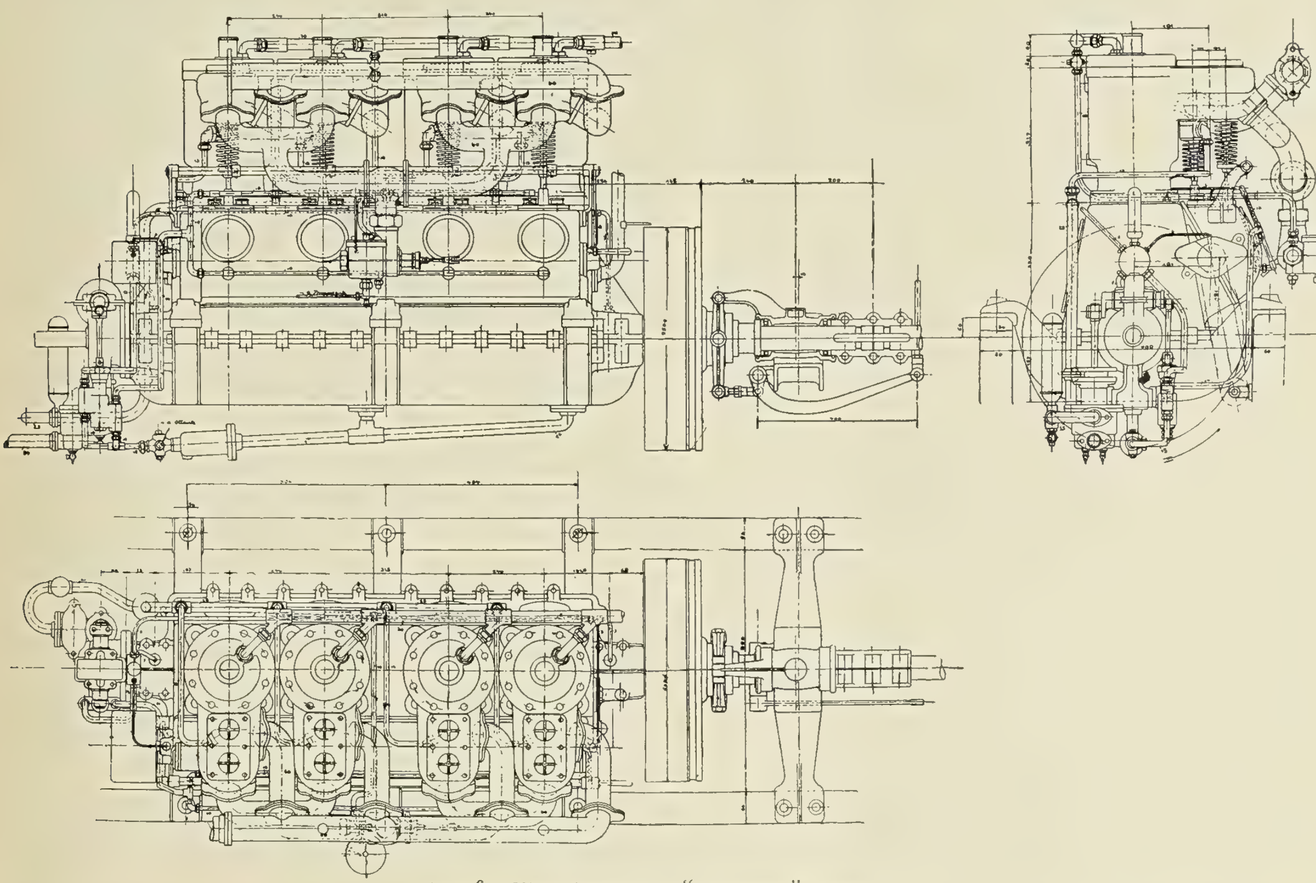


FIG. 6.—FORTY-HORSEPOWER "REVERSATOR" MOTOR.

originally patented by Mr. F. G Ericsson cannot be employed in multiple-cylinder motors.

In order to explain fully the process of reversing we must add a few words regarding the arrangements for ignition. The inflammable gas mixture is ignited in the ordinary manner by the aid of an electric spark, produced either from a battery alone or from a battery in combination with a magnetic inductor. The contact is formed and broken by a fixture keyed to the operating shaft, in such a manner as to allow of its position being altered while the motor is running. This alteration, which causes a varying timing of the ignition, is accomplished simply by turning a small lever on the maneuvering dial.

The maneuvering dial is generally fixed to a pedestal carrying the steering wheel of the boat in addition to a small lever

To cause the motor to develop its highest efficiency, the ignition must occur just a moment before the piston has arrived at the upper end of its compressing stroke. If at the same time the motor is to run "ahead," the maneuvering lever must be locked in position at "full"; the lever being removed from this position to a position marked "ahead" alters the ignition, so that it occurs later; *i. e.,* after the piston has traveled part of its downward expansion stroke. The combustion pressure and the speed of the motor are thus reduced, until a convenient speed for reversing is obtained. The lever is now moved past the position marked "stop," at which the ignition becomes suspended, and over to "astern"; a proceeding which causes ignition to occur when the piston has completed only a part of its upward compressing stroke. Now

FIG. 7.—OPEN LAUNCH "TIRFING."

combustion takes place, and the pressure above the piston rises suddenly to 80 or 90 percent above the pressure indicated by the ordinary expansion curve, as shown in the diagram (Fig. 4). The counter pressure thus thrown on the piston surmounts the momentum of the moving parts of the engine, and the crank is thrown back in the opposite direction to that in which it was just moving.

The motor having started to run "astern," continues to do so at reduced speed, as the ignition does not occur until the piston has traveled a considerable part of its downward expansion stroke. By removing the maneuvering lever from "astern" to "full," and locking it in this position, the ignition is timed to occur just before the piston has concluded its compression stroke, thus causing the motor to develop full power astern with the same number of revolutions as when working full power ahead. Reversing from astern to ahead is accomplished in a similar manner to that just described. The motor performs these maneuvers without shocks or extra vibrations; in fact, the reversing is hardly noticeable to a passenger turning his back to the operator, even in the case of lightly-built racing boats.

The considerable rise of pressure during the reversing stroke (see Fig. 4) is rather astonishing, but may easily be explained by taking into account several circumstances connected with the slowing down of the motor just before reversing; *i. e.,* a more complete admission of combustible gas than when running at full speed and reduced loss from leakage and cooling.

The curves shown in Fig. 5 are worked out from a number of diagrams, obtained from a Reversator motor with only one cylinder, provided with an air-inlet valve, operated automatically by the vacuum produced during the suction stroke. *a* represents the ordinary expansion curve; *b* is a curve connecting the points of maximum pressure indicated at different grades of belated ignition, and *c* is a curve connecting the points indicating combustion pressure when reversing at various positions of the piston in its compressing stroke.

In Fig. 4 are reproduced some diagrams actually obtained from the above-named motor just before and after the reversing moment. Those diagrams show plainly how the ignition takes place later and later on during the expansion stroke, owing to the displacement of the maneuvering lever. Finally, the ignition is caused to occur during the compression stroke, and the piston is reversed after having traveled nearly two-thirds of this stroke. The wavy shape of the expansion curve in these diagrams is attributed to vibrations in the pressure spring of the indicator, caused by the explosions.

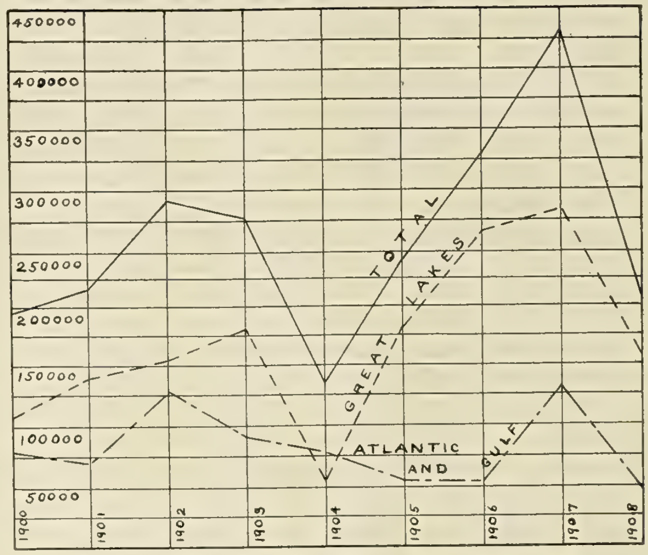
A few words may be added relating to the method employed for starting the motor. The combustible gas mixture is first drawn into the cylinder either by means of a vacuum pump or by turning the crank shaft around a few revolutions; a special arrangement being provided for avoiding compression during this operation. Ignition is also prevented by fixing the maneuvering lever at "stop." When the cylinder has become loaded the lever is moved to "ahead" or "astern," which causes ignition, and the motor starts running. The starting is quite an easy matter, and involves no risk whatever. Multiple-cylinder motors may be started simply by turning the maneuvering lever to "ahead" or "astern," provided that the motor has just recently been running.

G. O. M. Olsson.

Shipbuilding in the United States.

Although reports from the Bureau of Navigation of the Department of Commerce and Labor showed a record year in shipbuilding for the fiscal year 1908, the record for the calendar year 1908 is an entirely different story. From Dec. 31, 1907, to Dec. 31, 1908, 1,112 merchant vessels, aggregating 287,603 gross tons, were built and numbered in the United States. This, as compared with 1,056 ships of 502,508 gross tons of the previous year, shows a loss of 42 percent. Also the average tonnage is less than that for any period during the last nine years with the exception of the year 1904.

Since the fiscal year 1908, ended June 30, it will be seen that almost the entire depression has come during the last six months. Furthermore, it is accounted for principally by the great decrease in steel steamship tonnage being built on the



STEEL STEAMSHIP TONNAGE BUILT IN THE UNITED STATES.

Great Lakes. This work has been practically at a standstill during the past six months; for 98 percent of the steel steamship construction on the Great Lakes, which comprises 73 percent of the total steam tonnage built in the country during the year, was constructed during the first six months of the year.

The tonnage of sailing vessels has increased 19 percent over that for 1907, and apparently this part of the shipbuilding industry has not been unusually affected during the past six months.

MERCHANT VESSELS BUILT IN THE UNITED STATES.

Year.	Ships.	Gross Tons.	Average Tons.	Great Lakes Ships.		
				Gross Tons.	Per Cent.	Average.
1900	1,102	365,791	332	129,973	35.6	1,476
1901	1,322	376,129	284	156,157	41.5	1,270
1902	1,270	434,005	342	158,230	36.5	1,521
1903	1,159	381,970	330	182,593	47.8	1,438
1904	1,063	265,104	249	54,042	20.4	819
1905	1,054	306,563	291	182,361	59.5	1,736
1906	1,045	393,291	376	268,085	68.2	2,197
1907	1,056	502,508	476	283,492	56.4	2,100
1908	1,112	287,603	259	157,672	54.8	1,168

STEEL STEAMERS BUILT IN THE UNITED STATES.

Six Months Ending	Totals.		Atlantic and Gulf.		Great Lakes.	
	Ships.	Gross Tons.	Ships.	Gross Tons.	Ships.	Gross Tons.
June 30, 1900	52	105,713	31	34,803	17	63,885
Dec. 31, 1900	40	91,244	20	44,179	16	44,626
June 30, 1901	64	144,021	31	46,297	30	91.994
Dec. 31, 1901	40	74,604	21	25,541	17	49,020
June 30, 1902	74	196,197	34	76,186	32	109,019
Dec. 31, 1902	42	98,516	26	52,385	12	43,248
June 30, 1903	69	153,389	33	54,411	29	88,412
Dec. 31, 1903	50	126,392	20	36,077	28	89,562
June 30, 1904	43	113,261	27	61,904	13	50,336
Dec. 31, 1904	31	19,472	25	16,955	5	2,498
June 30, 1905	42	139,883	17	39,822	24	99,999
Dec. 31, 1905	51	100,127	27	18,843	21	80,932
June 30, 1906	58	181,614	25	24,378	31	156,792
Dec. 31, 1906	56	146,177	33	35,895	21	109,471
June 30, 1907	66	214,488	38	75,564	26	129,242
Dec. 31, 1907	69	216,181	34	53,167	31	151,272
June 30, 1908	72	200,923	18	34,144	44	153,107
Dec. 31, 1908	26	13,503	13	10,369	10	2,987

ADAPTABILITY OF PRODUCER GAS FOR MARINE WORK.*

BY E. SHACKLETON, A. M. I. MECH. E.

Notwithstanding the fact that the producer gas plant is the prime mover in the shops of many shipbuilders, both shipbuilders and marine engineers seem to be exceedingly chary of giving a trial to the gas engine in boats they build or engine. It is natural that after their intimate acquaintance with the steam engine and its traditions, which, in many cases, dates from over half a century back, they should be very reluctant to adopt a new type of prime mover which but a few years ago was regarded as only suitable for operating light printing machinery where the power required did not exceed 10 horsepower. The natural opposition of the steam-engine builder to anything in the nature of a gas engine was, up to a few years ago, very acute, and to-day in many cases it still exists. However, the economic law must eventually prevail, and, by reason of severe competition, ship owners will be driven in the near future to ask from the builders a type of boat which can be operated more cheaply as far as fuel consumption is concerned, particularly in the case of cargo vessels from 4,000 to 5,000 tons gross.

The present type of steam engine employed is no doubt very economical as far as steam goes with a coal consumption under favorable circumstances of slightly over 1 pound per indicated horsepower per hour. More common figures for coal consumption, however, are from 1¾ to 2 pounds per indicated horsepower per hour. Even if superheated steam is employed, with its attendant wear and tear, it is questionable whether a consumption of 1 pound per indicated horsepower per hour can be maintained.

The only substitutes now available for the steam engine in marine work are the oil engine and the gas engine. The gas engine and producer plant appear to be more directly suited to marine requirements than a large oil engine, notwithstanding the extra inducement which the latter offers as being self-contained. It is, however, very questionable whether the problem of dealing with every description of crude oil as a fuel in an oil engine has been definitely solved, and, even in such event, it is very doubtful if there is any real advantage over the producer plant in power cost. It must also be borne in mind that the most suitable type of engine for operation with crude oil is somewhat complicated and expensive to build.

The writer offers the following scheme as a possible solution of the problem for cargo vessels of from 4,000 to 5,000 tons gross: For fuel, producer gas, generated in a plant of the suction type such as are now in successful operation on land; for prime movers, a vertical tandem inclosed gas engine of 700 brake horsepower with two secondary sets of crank chamber gas engines each of 250 brake horsepower. Each of these three engines to be coupled to a dynamo supplying power to two motors on the propeller shafts either of 400 or 500 kilowatt capacity, together with the usual main switchboard and accessories. The steering gear would be operated by an electric motor of suitable design and power. The usual pumps, of the centrifugal type in this case, would also be operated by electric motors, namely, the bilge, ballast and circulating pumps, the latter being employed for the cooling water of the gas engines. A small oil engine of, say, 6 brake horsepower would be used for lighting the ship when in port. Without attempting to go into smaller details, which, of course, are impossible to specify correctly until the dimensions, space and conditions of a ship so fitted can be definitely decided on by the shipbuilders, it will be seen that this equipment calls for nothing which is not now in the market; in other words, it is a commercial possibility.

* Read before the Institute of Marine Engineers, London, December, 1908.

The cost of repairs for a plant of this type varies somewhat, but the following may be taken as approximately correct:

	Per annum.
For 100 horsepower, about £4	$19.47
For 200 horsepower, about 6	29.20
For 300 horsepower, about 9	43.80
For 400 horsepower, about 12	58.40
For 500 horsepower, about 15	73.00

The cost of cleaning and repairing the boilers used for a steam plant of similar size is much more serious.

On a suction producer gas engine of 360 brake horsepower, running at 200 revolutions per minute, the cylinders should have liners of special hard close-grained cast iron, which may be easily re-bored when worn. A space between the liner and outside of the cylinder forms the water jacket which keeps the cylinder cool by means of a constant circulation of water. The piston should be of the bucket type made of hard close-grained cast iron fitted with metallic piston rings and coupled to the connecting rod by means of a hardened and ground piston pin. The engine bed should be a massive hollow casting, which, in the case of a horizontal engine, is prolonged under the cylinder to reduce the overhang to a minimum. This improvement prevents vibration and the working loose of the engine on its foundation, which so often occurs with engines having long overhanging cylinders. The crank shaft should be of Siemens-Martin steel forged from the solid and running in adjustable white metal bearings having ample wearing surface, intermediate bearings to be fitted between each crank. The flywheel should be of extra weight in order to insure steady running and should be 8 feet in diameter by 15 inches wide on the face.

A sensitive governor of improved construction should be provided, and so arranged that changes in speed can be made without stopping the engine, the governor controlling automatically the amount of gas consumed according to the work done at any period. Independent magneto-ignition with a time adjustment should be fitted. The air and gas valves should be fitted into loose cast iron boxes or valve plugs, which can be easily removed for cleaning and repairs. The joint between the valve plugs and the cylinder should be a ground metal-to-metal joint. The valves themselves and the covers should be hollow and water-cooled. The piston, crank pin, main bearings and all moving parts should be lubricated and forced lubrication should be used for the cylinder crank shaft and connecting rod bearings and exhaust cam shaft, with ring lubrication to the inlet cam shaft. The gas gag should be of cast iron with a rubber diaphragm.

Reversing is beyond a doubt a most important function in marine work, and it must be an operation that can be carried out with certainty and without delay. To reverse a gas engine of any size would, and will be, an extremely complicated process. While it is recognized that a reversible gas engine is an accomplished fact, it is probable that under the very onerous conditions of marine work the increased wear and tear and complication of the reversing mechanism would result in a sacrifice of efficiency and reliability. With the electric drive proposed, the reversing process is, of course, easily carried out by means of the motors attached to the propeller shaft.

Although the writer advocates electric drive, it is clear that to shipowners who do not require more than 600 or 800 brake horsepower the expense of this type of drive would probably deter them from building a steamer fitted with a gas engine. There are, however, on the market several reversing friction clutches which could possibly in a modified form do all that is expected if the full power were not desired for going astern. There is no reason to suppose that they would not perform their duties satisfactorily. Where twin screws are employed,

reversing may be confined to one propeller, which, under all ordinary routine conditions, should prove satisfactory, although being somewhat slower in action. In such a case as this, the proposal submitted as to electrically-driven winches would still be carried out, except in the case of a sailing vessel. One concern now constructs reversing gears in sizes up to 2,500 horsepower, and it has made several gears of large sizes suitable for marine work. In these clutches the gear is always in mesh; consequently the clutch is perfectly silent when running ahead and almost noiseless when going astern. It has one positive speed ahead and astern. When desirable the speed can be regulated and the boat slowed down by manipulating the starting gear.

The inclosed type of gas engine recommended for consideration in this scheme appears to be admirably adapted for marine conditions. This type is well balanced, positively lubricated and, being inclosed, any leakage of gas that might pass the pistons is confined to the case. Its speed is higher than certain types of gas engines, but at such speeds gas engines of the type referred to run, as a rule, steadily without great vibration. It is not anticipated that the sole plate or bed foundation would present serious difficulties to the shipbuilder. The system of governing these engines compared with steam engines is a decided advantage, as there is no hit and miss, but positive throttling by varying the quantity and quality of explosive mixture. Engines of the tandem type have also proved themselves to be very reliable and admirably adapted for this class of work.

For the purpose of starting these engines, that is, charging the compressed air reservoirs, it is proposed to use the small oil engine which is also used for ship lighting. It is not intended for the limited power required for a 3,000 and 4,000-ton gross gas-driven ship to introduce the bituminous producer. While it is recognized that such a producer would undoubtedly be of great advantage for marine purposes, the writer feels satisfied that anthracite is now sufficiently available to economically answer all the requirements of a cargo boat running on a fast route. This fuel is available outside Wales, in America, New Zealand and various parts of the Continent. Even if it were not available, recourse could be made to good coke. As far as can be seen, it is, moreover, questionable whether for powers not exceeding 2,000 brake horsepower the bituminous plant would really be such an advantage as would otherwise appear. Outside its main feature, the ability to use common fuel, it is cumbersome, decidedly more complicated in its action, requires considerably more attention, and is almost twice as heavy as the suction gas plant. Ammonia recovery would also be out of the question on shipboard. While it is recognized that the ability to use a common fuel is certainly a great advantage, it appears to the author that the simplicity of the suction plant will in the long run outweigh such advantages for moderate powers under marine conditions.

In making comparative tables of cost of a gas-driven and a steam-driven ship the writer has in mind that anthracite is more expensive than Welsh steam coal, and also than North Country coal, but, taking into consideration the pros and cons, this is an all-important feature. It would doubtless be necessary, however, to use a bituminous producer plant for powers exceeding 2,000 brake horsepower.

The fairly regular load in marine work would suit a producer plant, and the fact that such plants would be worked continuously is favorable to the producer. In fact, a more uniform gas of even quantity is likely to be produced with corresponding fuel efficiency than would be the case where the plant is shut down at the end of the day. The bogey of door troubles, etc., is very much over-estimated and under the intelligent eye of the average marine engineer little or no trouble should arise from this source. It is proposed to have the generators in four small units, so that in the event of any repair or cleaning one may be shut down till this has been effected without interference with the production of gas from the rest of the plant. When anthracite is not available, good gas coke, which can be obtained almost anywhere, may be used with good results on a slightly higher fuel consumption. Coke, however, requires more attention at the generator, and the gas made from it is not so clean as that made from anthracite. Scrubbers should be made extra large, and sea water should not be used for direct use in the gas plant, as the vaporizer would quickly become incrusted with salt and cease to make steam.

Objection will no doubt be made to the proposed speed of the propellers, as 250 or 300 revolutions per minute is, of course, much higher than is used in the present cargo boat. While it is recognized that a low-speed propeller has certain advantages, it must be borne in mind that they are more or less in ratio to the present steam-engine speed, which could not well be higher. The writer is of the opinion that where a high-speed propeller will be found necessary the shipbuilder will quickly adapt himself to the exigencies of the position. The electric motors for driving the two propellers would of necessity occupy more space near the propellers than the present tunnel permits, but this is also a matter which the shipbuilder could allow for without any serious expenditure when the boat was being built.

Doubtless the cost of the electrical equipment which has been outlined would be heavier than the average steam plant by about £6,000 or £7,000 ($30,000 or $35,000), but apart from the huge saving in fuel consumption for the steamer, the reduction of strain on the hull, due to a short shaft at the propeller end, and the electrical drive, together with the great advantage that in bad weather a very effective method is offered to prevent racing, would be invaluable. Another objection to the electrical drive may be urged on account of the loss of power from the dynamo to the motor. This would probably be about 15 percent and is no doubt an item of some importance, but let it be considered that, while electrical losses are a measured quantity, frictional losses from the present system of drive are bound to be fairly high, probably 10 or 12 percent, and are practically unmeasured quantities.

One very strong feature of the scheme under consideration would be the arrangement for electrically-operated winches, one of the smaller units in the engine room driving a dynamo for the purpose of discharging cargo. Undoubtedly the fittest place for any power generation is the engine room, instead of the present system of ten or more scattered steam winches.

Sea water would be used for the scrubbers attached to the gas producer and also in the engine jackets. It is not likely that sea water would cause any trouble in the engine jackets, since large volumes of water are circulated and the water is not allowed to boil there.

Although, in view of the high efficiency of the electric motor, troubles are now of quite rare occurrence with well designed machines, provision ought to be made for even such remote contingencies as the burning out or fusing of the motor. It is suggested that this should be accomplished by the addition of a propeller on an emergency shaft, the same being directly in line with one of the power units, so that in the event of the tunnel becoming flooded or the motor rendered useless from other causes, the shaft could be brought into operation and slow speed maintained for some time through the direct drive from the engine

The small oil engine previously mentioned performs a double purpose. It might frequently happen that when a cargo boat is in port there would be periods when light is desired for use on the ship, for which it would be obviously uneconomical to run one of the smaller gas units. The small oil engine could supply power for sixty 16-candle-power lamps.

As to the type of boat where gas engines could be employed as an auxiliary method of propulsion, the writer is of the opinion that the installation of a 400 or 500 brake horsepower gas-driven plant could be adapted to large modern sailing vessels, in which case, of course, the use of one or two propellers would be recommended. There is every reason to believe that such an arrangement would prove exceedingly economical. The engines could be stopped when full sail was available and the speed could be considerably increased with very light winds. Of course there would be a slight reduction in the cargo space available, and also a skilled engineer would have to be carried, but the increased speed would doubtless prove a sufficient inducement to shippers who desire reasonable time voyages. With a boat of, say, 2,000 tons gross, from 5 to 6 knots under power alone would be feasible in moderate weather.

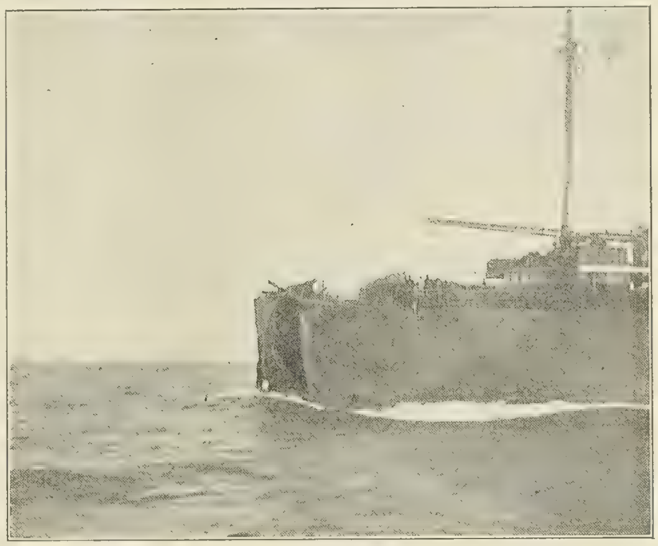
A DISASTROUS COLLISION.

Early Saturday morning, Jan. 23, the White Star Liner *Republic*, bound from New York to the Mediterranean, collided with the *Florida* of the Lloyd Italiano Line, bound from Naples to New York. The collision occurred off Nantucket, after the *Republic* had proceeded 193 miles from Sandy Hook. The weather was foggy, and both ships were proceeding under reduced speed. The *Florida* struck the *Republic* on the port side, tearing a large hole both above and below the waterline in the engine-room space. The bow of the *Florida* was demolished, and the two forward compartments immediately filled with water. The collision bulkhead, however, prevented any further damage to the vessel, and she was able to proceed under her own steam to New York.

The engine room of the *Republic* was almost immediately flooded, there being only time for the engine-room staff to close the watertight doors in the engine-room bulkheads before making their escape. Through the failure of the after watertight bulkheads, the after part of the vessel was gradually flooded, and after remaining afloat forty and one-half hours she sank in 45 fathoms of water.

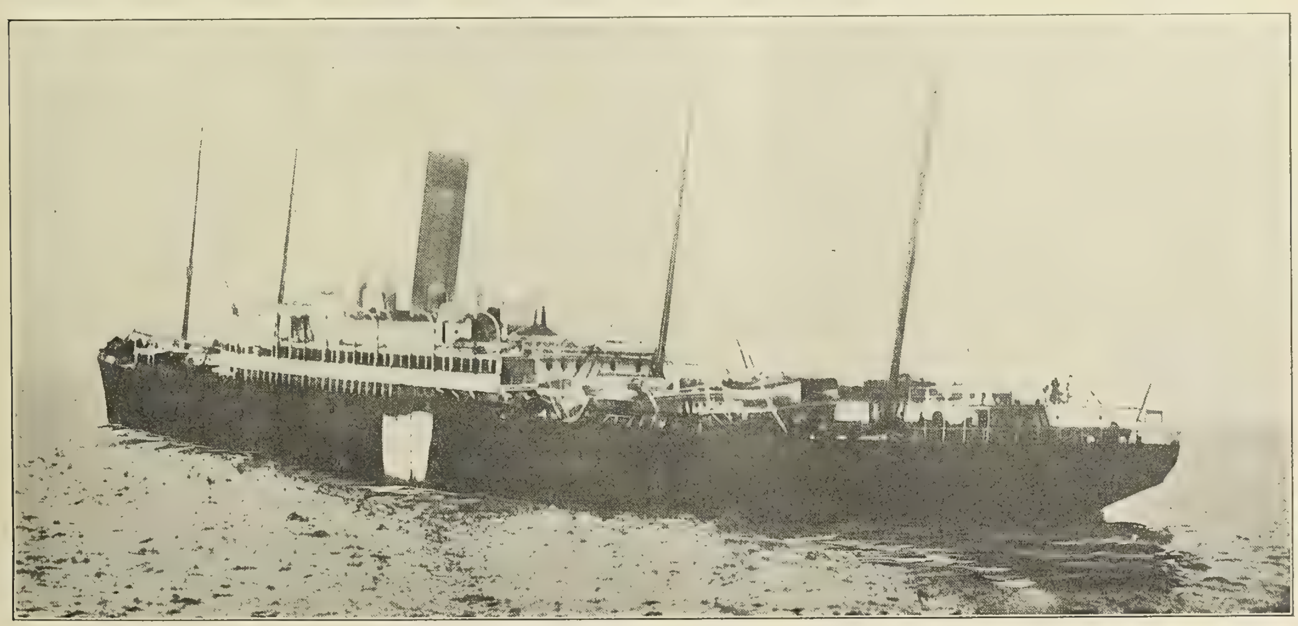
Seven lives were lost and three were injured, the loss of life being due entirely to the effects of the collision. The rest of the passengers and the crew were safely transferred from the *Republic* to the *Florida*, and finally to the White Star Liner *Baltic*, on which they were brought to New York.

The *Republic* was a steel, twin-screw steamship of 15,378 gross tons. Her dimensions were: Length, 570 feet; breadth, 67.8 feet; depth, 24 feet. Her propelling machinery consisted of two four-cylinder quadruple-expansion engines, with cylinders 29, 41½, 61 and 87 inches diameter by 60 inches stroke, the nominal horsepower being 1,180. She was built in 1903 by Harland & Wolff, Ltd., at Belfast. The *Florida* is a steel, twin-screw steamship of 3,231 gross tons, built in 1905 at Genoa, Italy, by the Soc. Esercizio Bocini. She is 381.4 feet long, 48.1 feet beam, with a depth of 25.7 feet. She is driven by two three-cylinder triple-expansion engines capable of developing a nominal horsepower of 444. The cylinder diameters are 21, 33, 59 inches, with a stroke of 39 inches.



DAMAGED BOW OF THE FLORIDA. (PHOTO FROM N. Y. HERALD.)

This accident demonstrates clearly the status of watertight bulkheads as at present arranged in passenger and cargo steamships as a means of keeping a damaged ship afloat. The engine room of the *Republic* was only about 50 feet long; and if the after-bulkheads had held, the loss of buoyancy due to flooding the engine room alone would not have resulted in the loss of the ship, although she was rendered helpless by the submerging of her pumps and engines. The gradual flooding of the after-holds seems to show that the bulkheads were not only not watertight, but not strong enough to withstand the pressure of the water.



VIEW OF THE REPUBLIC SHORTLY AFTER THE COLLISION. (PHOTO FROM N. Y. HERALD.)

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The Possibility of Gas Propulsion.

With the most efficient type of steam plant now used for marine work only 10 or 11 percent of the total heat value of the coal consumed is realized in actual work at the propeller shaft. Although a coal consumption as low as 1 pound per indicated horsepower per hour can be obtained with reciprocating engines under the best of conditions, yet this is not usual. Under average service conditions a consumption of 1½ pounds per indicated horsepower per hour is considered a very good performance, while an average value would probably be much nearer 2 pounds per indicated horsepower per hour. On her official trials the latest United States battleship, which is fitted with watertube boilers and reciprocating engines, showed a coal consumption of 1.74 pounds per indicated horsepower per hour, which would be equivalent to about 1.98 pounds per brake horsepower per hour, assuming the brake horsepower to be about 88 percent of the indicated horsepower. The *Lusitania,* with Scotch boilers and turbine engines, consumed on trial 1.43 pounds of coal per brake horsepower per hour, while an average value of 1.8 pounds per indicated horsepower per hour is the result of records covering a large number of steamships of various types operating on the Great Lakes of North America, where refinement in steam plant design is carried to extremes.

Experience on shore with gas engines operating on producer gas has shown that this type of prime mover is capable of developing a brake horsepower on 1 pound of coal or less per hour. About 17 percent of the heat value of the coal consumed is turned into useful work at the engine shaft, or nearly twice as much as can be obtained from a steam plant with reciprocating engines and about one and one-half times as much as can be obtained from a steam plant with turbines. Furthermore, the sum of the two principal heat losses in a steam plant—that is the stack and condenser losses—is nearly equal to the sum of the two most important heat losses in a gas plant, namely: the jacket and exhaust losses; but whereas there is little prospect of utilizing the heat thus lost in a steam plant, there is a possibility of utilizing at least a portion of that loss in a gas plant. It is inevitable that a form of power plant which theoretically offers such marked increase in economy of fuel consumption, shall sooner or later be developed in a practical way, and the past year has marked a substantial beginning in the development of the marine gas power plant. The first ship of any size and importance in the United States to be equipped with such a plant is described in our leading article this month.

At the present time the gas producer seems to have attained a more satisfactory development for marine work than has the gas engine, at least for large power. For reasons of simplicity, utility and safety, the suction type of producer has been advanced as the most suitable for marine work. It is obvious that a successful marine gas producer must be capable of using bituminous coal, and the great weight and large floor space required for most stationary bituminous suction producers have led many to believe that it could not compete successfully with steam boilers. It is true that on shore about two-thirds of the suction gas producer plants in operation in the United States use anthracite coal, while charcoal is used in a few cases, but it was pointed out by Mr. R. E. Fernald, of the U. S. Geological Survey Fuel Testing Corps, in a paper presented before the May meeting of the Western Society of Engineers, that although bituminous coal is used in only approximately one-third of the total number of suction producer plants, nevertheless this third probably covers in the neighborhood of from 65 to 75 percent of the aggregate horsepower in use, so that successful bituminous suction producers are an accomplished fact.

The type of plant used on shore is manifestly unsuited for marine work, because it weighs as a general rule over 200 pounds per brake horsepower and occupies a floor space of about 1 square foot or more per brake horsepower. The boiler-room weights of battleships equipped with watertube boilers average about 110 pounds per brake horsepower, while with Scotch boilers this figure is considerably increased. For ordinary cargo and passenger ships equipped with Scotch boilers the boiler-room weights do not run very much below 200 pounds per brake horsepower,

while the space occupied by watertube boilers is about one-third of a square foot per brake horsepower.

Gas producer plants designed especially for marine work can be built weighing from 75 to 90 pounds per brake horsepower, and occupying a floor space of from $\frac{1}{4}$ to $\frac{1}{3}$ of a square foot per brake horsepower. Thus it is evident that the marine gas producer has a decided advantage both in weight and space occupied per brake horsepower over the steam plant. The only type of marine steam plant which offers greater advantage than the gas producer and gas engine in this regard is that used on torpedo-boat destroyers, where the fire-room weights are as low as 30 pounds per brake horsepower, and the space is only about 1/8 of a square foot per brake horsepower.

Coming to the question of the gas engine, we find that at the present time it is impossible to obtain engines much larger than 500 brake horsepower. Six cylinder, double-acting engines of this size, however, are of light weight, some being as low as 30 pounds per brake horsepower, whereas engine-room weights for a steam plant usually do not run much below 65 or 70 pounds per brake horsepower. The reason that larger engines have not been built is very largely due to the fact that a cheap fuel has not been available. The cost of operating engines of even 500 horsepower on gasoline is, in most cases, prohibitive. The development of a successful marine gas producer capable of using bituminous coal, which is now an assured fact, will undoubtedly give a decided impetus to the development of large marine gas engines; and there is every reason to believe that the success which has attended the development of engines up to 500 horsepower will be achieved in the development of larger engines.

The rapid development of large gas engines on shore has been in a direction entirely unsuited to meet the requirements of marine engines. Stationary engines of 5,000 or 6,000 horsepower are usually of the horizontal, twin-tandem, double-acting, four-cycle type, the maximum diameter of cylinders being about 44 inches. These engines, however, are very heavy, and massively built, their weights running from 300 to 500 pounds per brake horsepower.

Although the difficulties to be overcome in the design of marine engines are vastly greater than those which were encountered in the development of stationary gas engines, yet they are by no means insurmountable. Such questions as reservability, adequate cooling of cylinders, pistons and valves, satisfactory handling of the exhaust, governing, etc., have been satisfactorily met in stationary practice, and the majority of the gas-engine builders claim that practical solutions are available for these problems in the marine engine. One important advantage which the marine plant has over the stationary plant is that of a practically uniform load at full power. Many large stationary gas engines are now used in electrical plants to supply power for lighting and electric railways. In such plants the load varies widely from hour to hour through the day, and for certain periods of the day is extremely small. The changes are abrupt, but even under these conditions an actual economy from coal pile to switchboard of 1¼ pounds of coal per brake horsepower per hour has been achieved. Under the uniform conditions of load which woud prevail in a marine plant, it is confidently predicted that a brake horsepower can be developed on ¾ of a pound per brake horsepower per hour, making the percentage of heat available in the coal which is utilized in useful work at the propeller shaft considerably more than 17 percent. Another advantage of the gas plant over a steam plant on shipboard is the fact that no fresh water is required, as salt water can be used equally as well.

Loss of the "Republic."

At the present writing everything seems to point to the fact that the sinking of the *Republic* was due to the failure of her water-tight bulkheads. The ship was rammed in way of the engine space, and that compartment was, of course, immediately flooded. There was barely time for the engine-room staff to close down the water-tight doors and make their escape before the water had submerged the dynamos and plunged the ship into darkness. The engine room of the *Republic* is about 50 feet long and is located just abaft the center of the ship. The flooding of this compartment alone and the amount of water which found its way into the adjacent compartments before the water-tight doors could be closed would not have been sufficient to sink the ship, although as it was the engine-room compartment which was flooded, the ship was, of course, immediately rendered helpless by the submerging of her pumps and engines. The fact that the ship remained afloat forty and one-half hours after the collision and then finally sank rapidly, stern first, led the chief engineer to express the opinion that one of the bulkheads in the after hold was finally torn away. The exact conditions may never be known; but the effectiveness of water-tight bulkheads, except the forward and after collision bulkheads, as installed in the majority of modern passenger and cargo steamships will be questioned more than ever as a means of rendering a vessel non-sinkable. In commenting further on the accident, the chief engineer expressed the belief that if two good pumps had been available the ship could have been saved, or at least she would have been kept afloat until towed into shallow water. This suggests forcibly the value of building a divisional bulkhead in both the engine and boiler rooms, so that in the event of a collision of this sort part of the ship's pumps and engines and boiler capacity would be available. This is a question which, in view of the remote possibility of the bulkheads ever being needed, and the fact that bulkheads so placed add little to the structural strength of the ship, but add excessive weight, is debatable.

Progress of Naval Vessels.

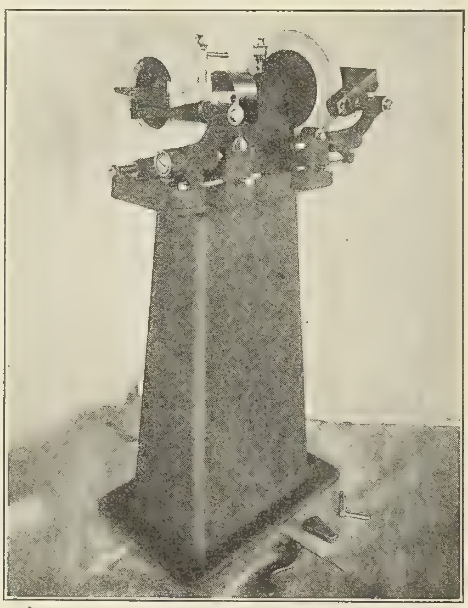
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Dec. 1.	Jan. 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons..........	69.9	75.1
Michigan ...	16,000	18½	New York Shipbuilding Co...	79.4	85.1
Delaware ...	20,000	21	Newp't News S.B. & D.D. Co.	54.9	59.0
North Dakota	20,000	21	Fore River Shipbuilding Co..	62.8	67.4
TORPEDO BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons..........	59.9	62.8
Lamson	700	28	Wm. Cramp & Sons..........	58.5	61.8
Preston	700	28	New York Shipbuilding Co...	54.9	57.9
Flusser	700	28	Bath Iron Works............	40.9	50.0
Reid	700	28	Bath Iron Works............	38.5	48.5
SUBMARINE TORPEDO BOATS.					
Stingray	—	—	Fore River Shipbuilding Co..	64.5	68.0
Tarpon	—	—	Fore River Shipbuilding Co..	63.0	66.9
Bonita	—	—	Fore River Shipbuilding Co..	60.8	63.0
Snapper	—	—	Fore River Shipbuilding Co..	58.2	62.3
Norwhal	—	—	Fore River Shipbuilding Co..	54.8	58.7
Grayling	—	—	Fore River Shipbuilding Co..	53.5	57.4
Salmon	—	—	Fore River Shipbuilding Co..	52.8	54.9

ENGINEERING SPECIALTIES.

A Novel Face Grinding Machine.

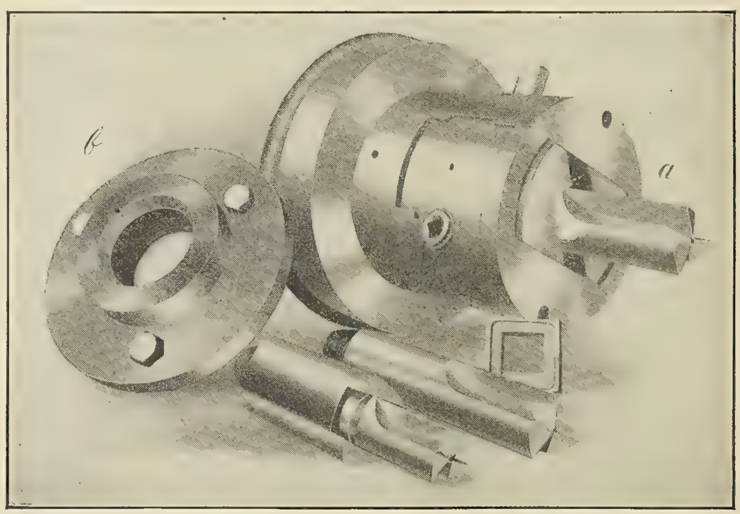
This machine is designed for grinding lathe and planer tools, for edge grinding and squaring up ends of work, and for the general miscellaneous small jobs of grinding in the tool room and in the shop. A straight edge or surface on tools and a straight face on the edges of work is much easier and more accurately obtained by using the face of the wheel, provided that face be straight and the wheel be of suitable character. Such a face cannot be obtained with an emery



wheel dresser nor can the diameter of the wheel be kept true with a dresser. Recognizing these facts, the manufacturers of this tool, the Emmert Manufacturing Company, Waynesboro, Pa., have provided a work table located in front of and extending by the edge of the wheel, so that both the face and edge of the wheel can be used for grinding. This table is located in a guide carried by a transversely swinging arm, and in the end of the arm a longitudinally adjustable diamond holder is located. Normally, the table can be either clamped, to prevent any transverse rocking movement, or adjusted to allow a certain amount of such movement, as is often an advantage in grinding wide work. When the surface of a wheel becomes dull or untrue an adjustable stop below the table is moved out of its path, and the table swung backward away from the wheel, at the same time swinging the diamond across the face of the wheel, so as to give the latter a good cutting and a straight surface. The table can also slide in a longitudinal direction in a guide, for truing off the edge of the wheel. The table guide is pivoted in the diamond-carrying arm, and can be set by means of graduations and clamped at any angle with the face of the wheel up to 45 degrees. Upon the table is also provided an adjustable squaring device or protractor, which may be set from 90 degrees to 45 degrees with the surface of the wheel.

A Triangular Bit for Boring Square Holes.

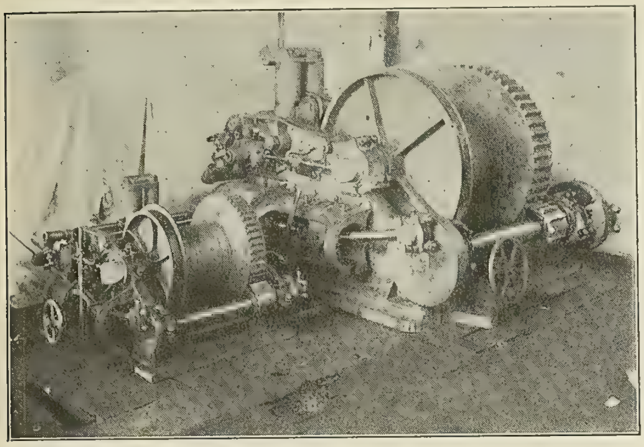
A tool has recently been placed on the market by the Radical Angular Drill Company, 114 Liberty street, New York, which, it is claimed, is capable of boring square holes with the same facility and with nearly the same speed that the ordinary twist or flat drill will bore a round hole in the same material. At the same time the tool, while not altogether as simple as the flat drill, is not complicated nor expensive, and is easily made or ground in the average machine shop. The only appliance needed for the use of this special tool upon such machines as lathes, drill presses and milling machines is a special chuck, which is really a device for making the three-cornered boring tool or bit travel about in such a way as to strike out a square hole in the work. It consists of a driving part which is screwed onto the spindle of the machine, a guiding part which either rides upon the first part, or else is secured permanently to the frame of the machine, and a third part, or socket, into which the shank of the drill is screwed. This third part is caused to rotate by the first part, but has a slight freedom of motion in relation thereto, being guided as to its exact movements by the matrix or frame in the stationary part. Where square holes are to be drilled the shank



of the tool is three cornered, the sides of the shank being formed by segments of circles struck from opposite corners as centers, the radius of these circles being the same and equal to one of the sides of the square hole which is to be drilled. The guide in the stationary part of the chuck is adjusted to the size of the hole to be drilled, that is, so that the sides of the square opening are just equal to the radius by which the circles used for striking out the sides of the shank are formed.

When one of the sides of the shank is either rolling or sliding upon one of the sides of the square guide, the opposite

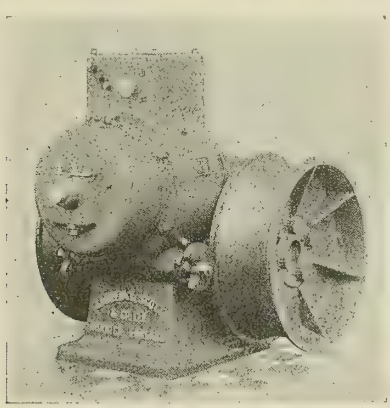
This machine has cylinders 16 inches by 16 inches, and uses a galvanized steel hawser 2 inches in diameter. It is equipped with the American Ship Windlass Company's patent automatic winding device, which consists of a pair of guide rolls, which move back and forth across the drum in such a manner as to lay the line evenly—no matter which direction it leads or how



often it is reversed. With such a device the line can be reeled in or paid out as rapidly as circumstances require, and there is no need for any manual attention. This automatic winding device is a comparatively recent invention, having been in service only two years, but in this time it has proven itself so useful that it is now regarded as an essential part of an up-to-date towing machine.

An Electric Hoist.

Orignally designed for the Admiralty some six years ago, the electrically-driven whipping hoist shown in the illustration has since been manufactured at the Gothic Works of Laurence, Scott & Company, Ltd., Norwich, for the navy and mercantile marine. The motor, as can be seen, is combined with the gear case. As it is compound wound, it only requires a simple



starting switch, which can be placed at a distance from the hoist below decks, where it can be kept dry; or, if this is not practicable, the more expensive deck pattern of starting switch can be used. Simplicity in operation is the chief advantage claimed for this type of hoist. There are no resistances which are liable to burn out. The whole machine is inclosed and watertight, so that it is quite suitable for fixing on deck exposed to the weather. Lubrication is automatic, so that the hoist is always ready for use whenever current is available. These winches are made in two sizes, one designed to lift at Admiralty rating 300 pounds at a speed of 180 feet per minute, and the other, by the same rating, 600 pounds at 180 feet per minute, so they are suitable for handling baggage on passenger ships.

COMMUNICATION.

Government versus Private Work.

Editor, International Marine Engineering:

In view of the editorial published on page 40 of your January issue, relative to government versus private work, the following comparison of the cost of docking, overhauling zincs and sea valves, painting and undocking in the case of a small naval cruiser which was docked at the Mare Island Navy Yard, in July, 1906; again in February, 1907, and which was docked at a commercial drydock in November, 1907, may be of interest:

ITEM.	July, 1906—N. Y., M. I. Nine Days in Dock.		
	Labor.	Material.	Total.
Docking	116.68	21.86	138.54
Overhauling zincs and sea valves	76.09	43.84	119.93
Painting	65.80	177.80	243.60**
Grand total	258.57	243.50	502.07
	February, 1907—N. Y., M. I. Two Days in Dock.		
Docking	246.50	22.60	269.10
Overhauling zincs and sea valves	19.00	16.70	35.70
Painting	43.10	237.60***	280.70
Grand total	308.60	276.90	585.50
	November, 1907—S. F. D. D. Co. One Day in Dock.		
Docking	......	......	289.50*
	225. contract † Making Zincs		
Overhauling zincs and sea valves	14.10	67.30	306.40
Painting	Contract 120.00	268.30	388.30a
Wharfage	......	......	6.10
Use of float	......	......	2.00
Grand total	......	......	992.30

** One coat of anti-corrosive (392 lbs.) and one coat of anti-fouling (560 lbs.).
*** One coat of anti-fouling (770 lbs.).
a One coat of anti-corrosive (504 lbs., about) and one coat of waterline paint (532 lbs., about).
} Rahtjen's Red Hand Brand.

* Docked at 15 cents per ton displacement.

† The zincs were made at the Navy Yard. The contractor furnished the necessary labor to drill and secure them and replaced all broken screws.

It is often very difficult to get a comparative line on the cost of similar work performed in government yards and in private yards. But this instance seems to afford a fair comparison. Please note the considerable difference between the cost of the work when done in the navy yard and the cost of the same work on a private dock. Particular attention is invited to the job of overhauling zincs and sea valves. At the July docking the vessel was in dock nine days, and the sea valves were ground in. At the February docking the vessel was in dock two days. No valves were ground in, but the zincs on the outside were replaced. At the November docking, where a commercial drydock was used, the work done was practically the same as at the February docking, except that the manufacture of the zincs, costing $81.40, was charged in with the item of replacing them, so that the real comparative figures for this item for these two dockings are $35.70 in the navy yard and $225 in private dock.

It should further be noted that the commercial dock was a floating dock, and it is generally conceded that docking on this type of dock is cheaper than on the graving dock at the Mare Island Navy Yard. H. S. Wright.

Naval Constructor, U. S. N., U. S. Navy Yard, Mare Island, Cal.

TECHNICAL PUBLICATIONS.

The Design and Construction of Ships. Vol. I. By Prof. John Harvard Biles. Size, 6 by 9 inches. Pages, 423. Figures, 281. London, 1908: Charles Griffin & Company, Ltd. Philadelphia, 1908: J. B. Lippincott Company. Price, 25s. net.

The author of this book has been lecturing for many years in Glasgow University on the subject of naval architecture, and, while these lectures were never published, notes have been taken from time to time, and these finally collected and elaborated, modified and rewritten, until they have now been incorporated into the valuable volume which has just come from the press. This volume deals only with the calculations and strength of ships. It is divided into three parts, the first dealing with areas, volumes and centers of gravity; the second with ship calculations, and the third, with the strength of ships. Throughout the entire book a complete mathematical demonstration of each subject is given, numerous illustrations being used where their use will in any way aid the student to an understanding of the problem. The book is not entirely a collection of mathematical demonstrations, however, as might be supposed from the subjects considered, but contains a great amount of practical information regarding all types of ships and various details of their construction. While the book does not pretend to lay claim to much originality, yet there is much in the book which, although hitherto published and quite generally known, is the result of investigations and the development of methods by the author himself.

Steam Turbines. By James Ambrose Moyer. Size, 6 by 9 inches. Pages, 370. Figures, 225. New York, 1908: John Wiley & Sons. Price, $4.00.

Written primarily for practical engineers who are designing, operating or manufacturing steam turbines, this book begins with a discussion of the simple problems of turbine design. Much that has not hitherto been readily accessible on the subject of nozzle design is carefully discussed in the opening chapters. After this, steam turbine types and blade design are taken up. Nearly eighty pages are devoted to complete descriptions of various commercial types of turbines now in use. The illustrations in this part of the book show, not only the main features of the turbine, but also a great many of the smaller details which can usually be obtained only by inspection of an actual machine. Turbine governors are described, and a chapter is devoted to low-pressure turbines. The chapter devoted to marine turbines is less than two pages long, and, consequently, simply gives a brief statement of the progress which has been made in the development of marine turbines, pointing out its advantages and disadvantages.

One subject which we have never seen treated so thoroughly before in any book on steam turbines is "Steam Turbine Economics," in which the question of the best conditions of vacuum, superheat and steam pressure are discussed. The data given on power plant economics, giving the cost of installations, will also be found of great value. The final chapter treats briefly of the subject of gas turbines.

Marine Propellers. By S. W. Barnaby. Size, 5½ by 8½ inches. Pages, 185. Figures, 56. Plates, 6. New York, 1908: Spon & Chamberlain. Price, $4.50.

This is the fifth edition of a book which for the past twenty-three years has been widely quoted as an authority on the subject of propeller design. This edition comprises very few changes, as recent experiments have not greatly altered the methods previously used for designing propellers. A note has been inserted giving the latest values obtained by Mr. Froude for the maximum efficiency obtainable at different pitch ratios, and this should be noted when the constants are being selected.

A short chapter has been added, giving some information as to the latest practice in designing propellers for turbine vessels. Another subject which has been added is the influence of depth of water on resistance, since much experimental work on this subject is now available, so that definite information can be given.

The chapters are as follows: First Principles; The Paddle-Wheel; The Screw; Experiments with Models and Their Application to the Determination of the Most Suitable Dimensions; Influence of Depth of Water on Resistance; Cavitation; Geometry of the Screw; The Hydraulic Propeller; The Screw Turbine Propeller.

The Boys' Book of Steamships. By J. R. Howden. Size, 8¼ by 5¾ inches. Grand Richards: London. Price, 6/–; $2.00.

Mr. Howden has followed his former book, *The Boys' Book of Locomotives,* with this present work, in which he deals in an exceedingly interesting and practical way with the steamship. He seems to have gathered his information from all sources, and has written in a very lucid style. The hundred or so illustrations are from excellent photographs, and make the whole volume very attractive. The first chapters deal in a general way with the principles of ship design, the coming of steam and the development of types. We were particularly attracted by the way the author deals with "The Engines" and "Propelling Machinery"; also the chapter, "Down in the Stokehold," is well told. The last section of the book is four chapters on ocean steamships, with special accounts of the chief ocean lines. It will be seen how comprehensive the book is when we state that the author covers the ground from Noah's Ark to the *Mauretania.*

Obituary

The death is announced of Dr. Francis Elgar, chairman of Messrs. Campbell, Laird & Company, and chairman of the Fairfield Shipbuilding & Engineering Company. Dr. Elgar was formerly assistant to the late Sir. E. J. Reed, and following this spent a period of four years at the Admiralty. This appointment he resigned to become adviser upon naval construction to the Japanese government. In 1881 he returned to England, and later became director of His Majesty's Dock Yards at the Admiralty. From 1892 to 1906 Dr. Elgar was director of and naval architect to the Fairfield Shipbuilding & Engineering Company, of which he became chairman in 1907. In the same year he also became chairman of Messrs. Campbell, Laird & Company.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

900,680. BOAT. WILLIAM B. MOTHERAL, OF NORTH McGREGOR, IA., ASSIGNOR TO GLIDING BOAT COMPANY OF AMERICA, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 2.—A boat having a wedge-shaped hull with a bottom curved in cross section, the greatest curvature being near the bow, and the least near the stern. Six claims.

901,157. SHELL OR CASING FOR STANDARD TORPEDOES. CLELAND DAVIS, OF THE UNITED STATES NAVY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO NATIONAL TORPEDO COMPANY, OF NEW YORK, N. Y., A CORPORATION OF MAINE.

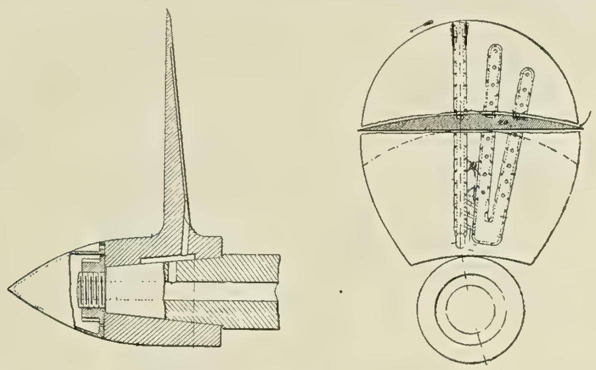
Claim 3.—A torpedo shell of standard length provided with a head adapted to slide and to be completely housed therein, and means to force said head outward into its firing position. Ten claims.

905,338. DISCHARGE DOOR OF HOPPER DREDGERS AND BARGES. FRED LOBNITZ, OF RENFREW, SCOTLAND.

Claim 3.—In hopper dredgers and barges having discharge doors, the combination with the doors thereof, of movable bars, means connecting the bars to the doors, a block with a slot therein, means for moving the block, and a wedge which can be driven through the block so as to simultaneously hold all the doors fast. Twelve claims.

900,797. SCREW PROPELLER. DAVID W. TAYLOR, OF WASHINGTON, D. C.

Claim 6.—The method of preventing cavitation at screw propellers which comprises admitting the air from the cavity formed at the back of the blades into the body of the blades and exhausting it therefrom by an

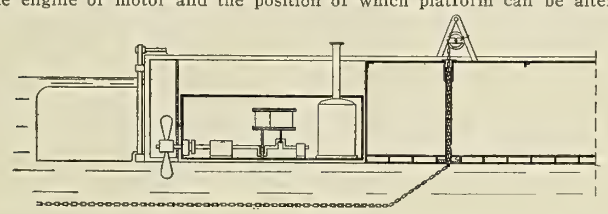


entraining current of water moved by centrifugal force through the blade.

Claim 14.—A propeller blade having a recess formed therein communicating with the cavity formed in the water at the back of the blade and means for automatically exhausting said recess. Fifteen claims.

905,377. RIVER BOAT. PIERRE SIGAUDY, OF LE HAVRE, FRANCE, ASSIGNOR TO STE. DES MESSAGERIES FLUVIALES DE FRANCE AND STE. AME. DES FORGES ET CHANTIERS DE LA MEDITERRANEE, OF PARIS, FRANCE.

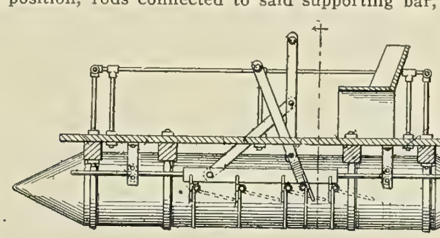
Abstract.—This invention relates to river boats, and comprises a movable platform arranged at the stern of the boat for supporting the whole of the propelling machinery, including the paddle wheels or the screw, according to which of these propellers is employed in addition to the engine or motor and the position of which platform can be altered



according to requirements. When the boat is provided with one or more screw propellers they can be caused to work entirely in the water. Moreover, the boat is provided with a traction chain or rope adapted to drag upon the bottom of the river or canal when required, so as to constitute a brake and enable the boat to resist the drawing action of strong currents. Two claims.

907,303. BOAT. ALEXANDER G. WILKINS, OF LOUISVILLE, KY.

Claim 1.—In a boat of the character described, a series of hinged paddles supported upon a bar, means for stopping said paddles in a vertical position, rods connected to said supporting bar, said rods being



mounted to slide between rollers journaled in brackets under the deck of the boat, and manually-operated means for reciprocating the supporting bars and paddles. Three claims.

907,629. PORTABLE FOLDING BOAT. PAUL J. MURPHY, OF MINNEAPOLIS, MINN.

Claim 2.—In a portable folding boat, the combination with a folding box-like frame adapted to house the hulls and the working parts when detached and placed therein, of a pair of hulls, each composed of a hollow cylinder having detachable and reversible cone-shaped end sections adapted to telescope therein, when reversed, to reduce the housing length of the hulls, the bodies of which are of less length than said box-like frame. Four claims.

908,016. METHOD OF RAISING SUNKEN VESSELS. SIMON LAKE, OF BRIDGEPORT, CONN.

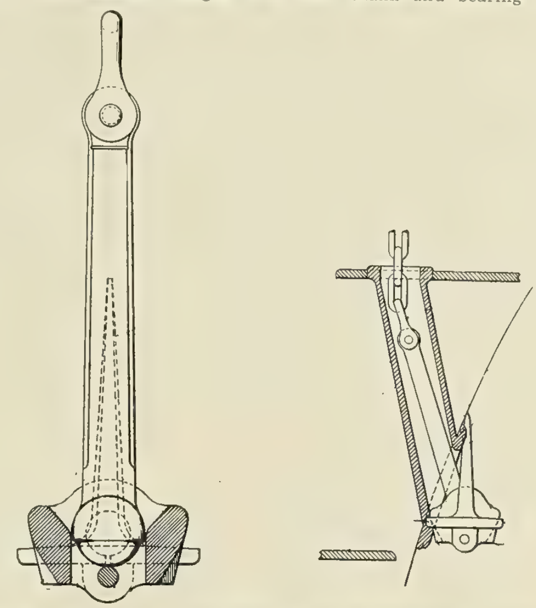
Claim 6.—The method of raising sunken vessels, which consists in closing the upper openings in the vessel and then forcing into the interior a fluent buoyant material capable of solidifying in water and containing paraffin and cork, said material being admitted in quantities sufficient to displace enough water to permit the vessel to be floated. Seven claims.

908,270. TORPEDO-LAUNCHING TUBE. ALBERT EDWARD JONES, OF FIUME, AUSTRIA-HUNGARY, ASSIGNOR TO WHITEHEAD & CO., OF FIUME.

Claim 1.—In combination with a torpedo launching tube, a rod arranged outside of the tube and displaceable lengthwise, said rod being connected with the firing mechanism, enlarged members formed on the rod passing through supporting boxes on the launching tube, said members being provided with grooves curved in opposite directions for engaging the torpedo stop and starting bolts. Six claims.

907,957. SNUGLY-STOWING STOCKLESS ANCHOR. WALTER S. BICKLEY, OF CHESTER, PA., ASSIGNOR TO BALDT ANCHOR COMPANY, A CORPORATION OF NEW JERSEY.

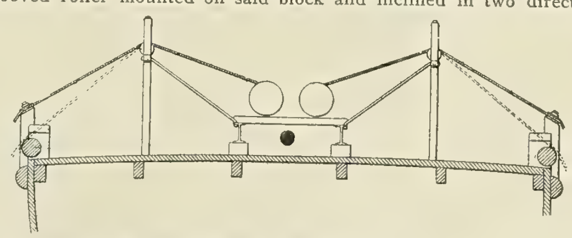
Claim 1.—In a stockless anchor, a crown member having flukes, a shank, a central opening in one side of said crown member to receive said shank, a substantially spherically shaped socket in said crown piece, a ball member integral with said shank and bearing in said



socket in said crown piece, the rear surface of said ball member being of continuous substantially spherical shape of less diameter, and a pin extending through said crown piece and in proximity to the continuous substantially spherical end of said shank. Twelve claims.

908,168. OYSTER-DREDGING CHOCK. WILLIAM C. TODD, OF CHANCE, MD.

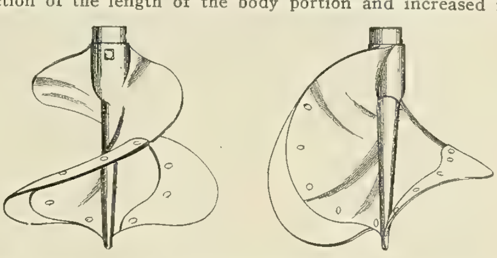
Claim.—A roller-chock for oyster-dredging vessels, comprising a block secured to the side of the vessel and at an elevation above the deck, and a grooved roller mounted on said block and inclined in two directions



with respect to the deck, to wit, downward or back toward the stern of the vessel, and also downward or sidewise from the deck toward the water. One claim.

908,226. SCREW PROPELLER. OLE P. EGGAN, OF SEATTLE, WASH.

Claim.—A screw propeller comprising a forward socket equipped with means for fixing it on a propeller shaft, a longitudinal central body portion formed integral with and extending rearwardly from said socket and having a rear, tapered end, and spiral blades extending in the direction of the length of the body portion and increased in width



from their forward ends to points near their rear ends, and each having an inner portion integral with the body portion and an outer portion attached to the inner portion and adapted to be removed and replaced with a new outer portion when necessity demands; the said tapered rear end of the body portion extending in rear of the rear ends of the blades, and the said blades being relatively arranged to form spiral channels between them. One claim.

909,321. TORPEDO. EDWARD O'TOOLE, OF LONDON, ENG.

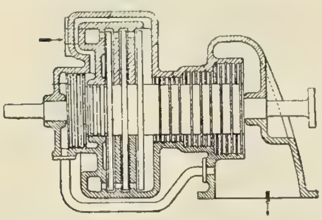
Claim.—A self-destructible torpedo comprising a submerged body, a propeller therefor, an engine arranged within the body and operatively connected with the propeller, an air pipe communicating with said engine and projecting continually beyond the water level with its upper end extending toward the rear of the body to prevent water from entering therethrough during the passage of the torpedo through the water, a fan driven by said engine to suck air into the body for said engine, an exhaust pipe leading from said engine, a brace arranged between the exhaust and air pipes and a stationary guiding vane connected to the body. One claim.

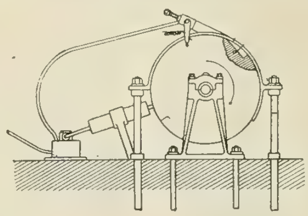
British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

15,361. TURBINES. J. KARRER, ZURICH, SWITZERLAND.
The annular steam jet from the last row of blades of a turbine is arranged to discharge into an adjacent chamber into which it draws water for its own condensations. The steam jet from the last rotor passes through fixed passages into the chamber, water being drawn in from another chamber. The mixture passes through a constriction to the discharge. The condensing water may be supplied under pressure, and the annular chamber may be placed internally. The arrangement is applicable to any turbine using condensible motive fluid.

16,186. RAISING SUNKEN SHIPS. J. HAIGH AND J. GOLDSWORTHY, WALLASEL, CHESHIRE.
Submerged or partly submerged ships are raised by means of tanks which are filled with water and attached to the hull, the water then being ejected by means of compressed air. The tanks are provided with tubes for the passage of the chain, and, after lowering, the free ends of the chain are connected by a shackle. The compressed air is admitted through flexible tubes and the water is forced out through valves. Other means may be employed for attaching the tanks to the object to be raised, and collision mats may be placed between the tanks and the hull.

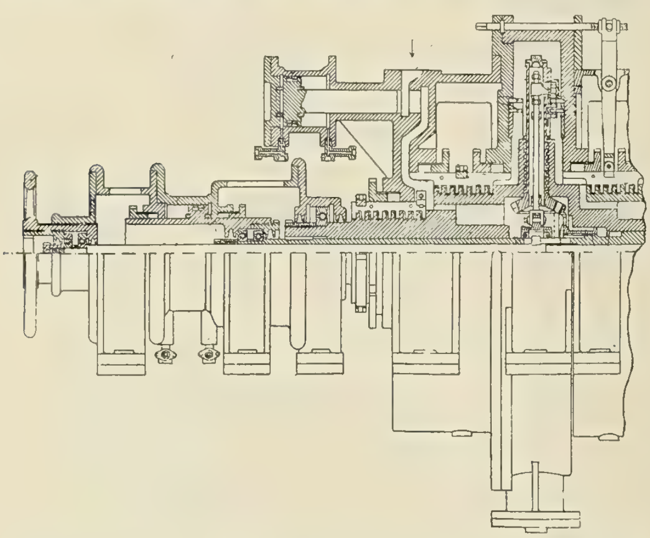
16,523. TURBINES. BROWN, BOVERI, ET CIE., AKT.-GES., KAFERTHAT, GERMANY.
In elastic-fluid turbines of the combined impulse and reaction type, the balancing piston is arranged at the high-pressure end of the turbine, so that its labyrinth packings are subjected to steam which has





passed through the expansion nozzles of the impulse part. A duct leads steam from a region between the impulse section and the reaction section to one side of the balancing piston. When the impulse section is of the Curtis type the wheel may be perforated and the connecting duct dispensed with.

16,996. TURBINES. J. PROCNER, PABLANICE, POLAND.
In a reversing turbine the nozzles and the corresponding bladings rotate and the intermediate bladings are fixed to the casing. In each stage two sets of intermediate bladings are provided, and to reverse the direction of running the nozzles and bladings are rotated to remove them from interaction with one set of fixed bladings to interaction with the other set. For this purpose the nozzles, etc., are attached to arms which are mounted to rotate upon their own axes within the arms integral

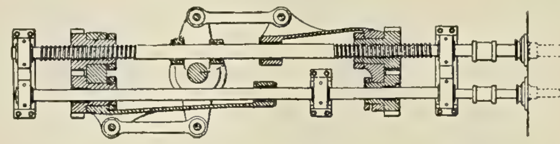


with the four-part shaft. Steam is controlled by a steam-operated piston valve and passes through the channel in the shaft to the center of the hollow arm and thence through the nozzles into the outer chamber. A channel connects this chamber to the center of the hollow arm of the next stage, and so on. The stages are separated by labyrinth packing between the shaft and the casing. The inner ends of the nozzle arms are provided with bevel wheels which engage with wheels on sleeves which are threaded internally with screw threads of very long pitch and engage with correspondingly cut surfaces on a tubular shaft mounted inside the main shaft. This shaft is splined to the main shaft. It is given an axial movement to rotate the sleeves, and thereby the nozzle-carrying arms, by a steam piston.

17,226. TURBINES. WARWICK MACHINERY COMPANY, LONDON.
In a multi-stage turbine in which the stages are separated by diaphragms, the steam from the last buckets of one stage is guided to the nozzles of the next by a passage formed in a block. The forward end of the passage is curved, and a valve is used to regulate the length of the passage. To compensate for the increased width of the passage the depth is reduced in the direction of the flow. Any escape of steam from the wheel chamber outwards is prevented by cylindrical walls.

18,046. TORPEDO TUBES. SIR W. G. ARMSTRONG, WHITWORTH & CO., AND E. W. LLOYD, NEWCASTLE-UPON-TYNE.
An above-water torpedo tube has a permanently closed rear end and a perfectly cylindrical chamber extending from the rear for a distance equal to the distance between the tail and the suspension tee-piece of the torpedo. It is loaded from the muzzle, the tail of the torpedo being passed sideways under the snout. A hole is provided to accommodate the charging-nozzle for the compressed air.

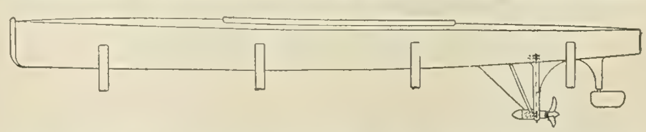
19,373. STEERING GEAR. T. L. LIVINGSTON, JARROW.
In a steering gear, a rudder-head which extends between the screw shaft and the guide shaft is provided with cross-beams, one above and one below the shafts. Levers connect the nuts to opposite ends of the cross-beams, and are so arranged that one is on the aft side of the rud-



der and the other is on the forward side, both being either in compression or tension. A bearing may be fitted on the rudder head to support one or both shafts, and the upper cross-beam may be dispensed with, the bearing being secured to the cross-beam by a circular standard, which is recessed into the upper surface of the cross-beam.

19,424. SHIPS. H. A. MAVOR, GLASGOW, AND J. H. BILES, WESTMINSTER.
A turbo-generator plant is employed for supplying the power to several motors driving the screw propeller shafts of cargo vessels. The generator plant is subdivided in separate units adapted to supply the current to the operating motors of the propeller shafts or the auxiliaries, the units into which the generating plant is divided being proportioned in accordance with the requirements of the different operating motors. One of the units smaller than the others may be used in the event of the failure of a larger unit, to propel the vessel at a reduced speed, or to operate the auxiliaries, the normal periodicity of this unit being half that of the larger unit. The main units of the generating plant may consist of turbo-alternators, while the smaller unit consists of a generator driven by a reciprocating engine, and capable of supplying either direct and alternating current or direct or alternating current, so that the auxiliaries may be driven by direct current.

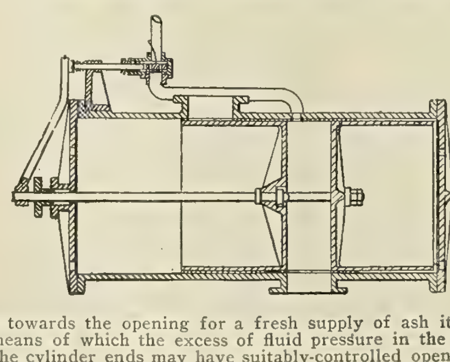
19,496. SHIPS' HULLS. W. P. THOMPSON, LIVERPOOL.
Curved aquaplanes of approximately catenary shape in a transverse direction are attached directly to the sides of the vessel, and, in addition, angular or curved fins are attached to the side of the vessel, but extending outwards. The screw propeller is mounted in a hollow column near the stern, and is driven by bevel wheel or sprocket-chain gearing



from within the vessel, or the propeller shaft may carry the armature of an electric motor completely enclosed in the column. The full catenary aquaplanes are placed in the center and forward parts of the vessel and also abaft the propeller near the stern, the partial aquaplanes being placed towards the stern. A partly floating paddle wheel may be fitted at the stern.

19,509. LIFE-BOATS; RAFTS. C. J. F. VOS, ROTTERDAM, HOLLAND.
Life-boats or rafts are constructed with inner and outer skins of plaited cane, wickerwork, etc., without any rigid framework. Between the skins is interposed a filling of yielding material, such as flock, cork, etc., preferably in three layers, the layers being separated by waterproof canvas layers.

20,107. APPARATUS FOR DISCHARGING ASHES FROM SHIPS BELOW THE SURFACE OF THE WATER. W. R. PRESTON, LONDON, AND G. C. RALSTON, TWICKENHAM.
A double piston with a space between its parts is adapted to reciprocate in a cylinder provided with inlet and outlet openings, respectively. The ashes are expelled through the outlet opening by means of compressed air, etc., the supply of which is governed by a slide valve operated by a tappet rod from the piston rod. As the piston moves



backwards towards the opening for a fresh supply of ash it uncovers a port, by means of which the excess of fluid pressure in the space is relieved. The cylinder ends may have suitably-controlled openings for the admission and discharge of sea water to remove grit in the cylinder.

20,241. VALVES. P. FERGUSON, J. B. PROVAN AND J. ROBERTSON, DUMBARTON.
A check valve for use in discharge pipes on board ship comprises two flaps of semi-conoidal form seating on one another and supported by means of eyes on pins. The pins are carried by lugs on a piece provided with projecting lugs to fit into recesses in the casing, and also with india rubber buffers. The valve casing is formed in the shape of a pipe bend and is closed by means of a cover.

International Marine Engineering

APRIL, 1909.

THE CAR FERRIES OF THE DANISH GOVERNMENT.

BY AXEL HOLM.

Although Denmark has been of only minor importance in the shipbuilding industry since wood has disappeared as a shipbuilding material, due partly to the necessity of importing both coal and steel and partly to the same troubles which have retarded shipbuilding in the United States, yet the country is still foremost in the construction and handling of car ferries. In fact, foreign civil engineers, both from Britain and Germany, very often pay visits to Denmark in order to study the design, construction and operation of these boats. Many years ago the numerous sounds and waterways separating the Danish islands led the railroads to resort to the use of ferries. These waters are too wide and the traffic not great enough to make bridges or tunnels feasible, although bridges at the Madsuedsund and Fredericia-Strib crossings are now being considered, and a railroad tunnel under the great belt from Korsoer to Nyborg has often been under investigation.

All the principal railroad lines in Denmark, and all those using car ferries, are in charge of the government. From a very small start in the year 1872, with a single iron-paddle ferry, the *Lillebaeltu,* the traffic has now grown up to a considerable extent, and so rapidly that some of the ferries had to be elongated only a few years after building, as will be seen from succeeding table. At present the government ferry fleet consists of twenty-two vessels, having a collective gross tonnage of about 15,000, exclusive of other vessels used in the railroad trade. Car floats are never used, and the ferries have only one or two tracks; those described here are only intended for railroad cars. Other vehicles are accommodated by special ferries. There are both paddle wheelers and screw steamers, and they are all built of steel (the older ones of iron), to the highest class of the Bureau Veritas, increased by the government's own requirements, based on thirty-six years of experience. As the crossings vary in length from about 2 miles at Fredericia-Strib to about 28 miles at the Gjedser-Warnemünde crossing, the types of ferries vary, too, from small single-trackers for the sheltered waters to big double-trackers for the open Baltic service.

As will be seen from the map, the ferry service takes place at eight crossings in the country, but at Malmoe and from Gjedser to Warnemünde one-half of the traffic is cared for by Swedish and Meclenburger ferries, respectively. In Table I. are shown the date of opening, length of travel, number of passengers and amount of goods conveyed and number of trips for different years, etc. In reference to this, it should be remarked that before placing ferries on the routes at Gjedser-Warnemünde and Elsinore-Helsingborg the government railroads had steamers plying at these crossings from 1886 and 1888, respectively, and that the ferry traffic between Copenhagen and Malmoe was cared for exclusively by the Danish ferry up to the year 1900.

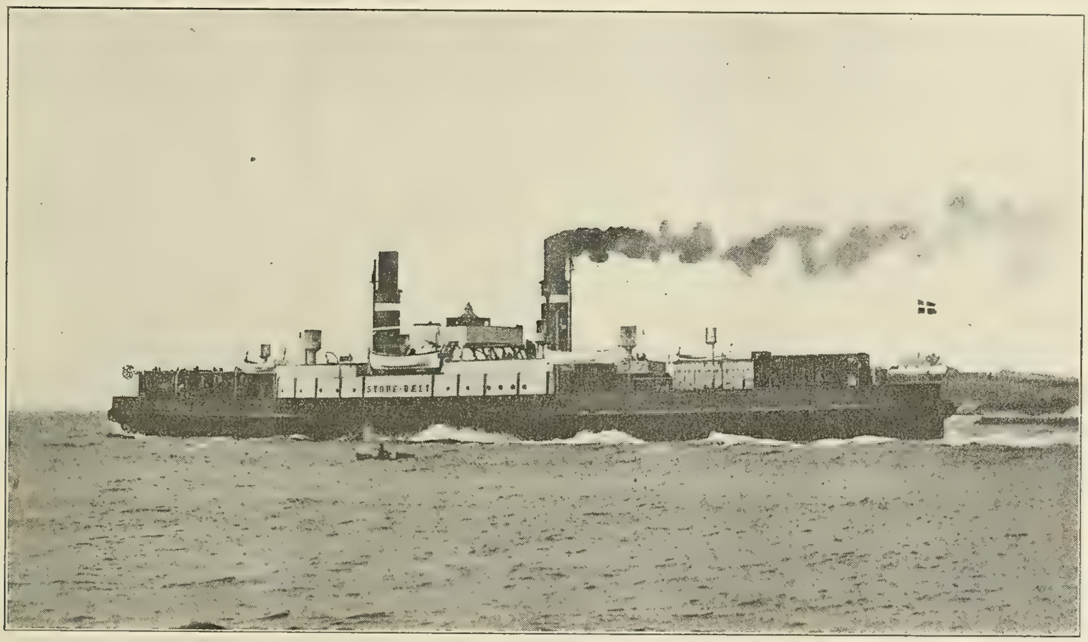


FIG. 1.—STEAM CAR FERRY STORE-BAELT AT KORSOER.

In Tables II. and III. are shown names, place of service and full data for the entire ferry fleet, and from these are selected for further description and illustration by drawings a specimen of each type, together with one of the ice-breaking ferries.

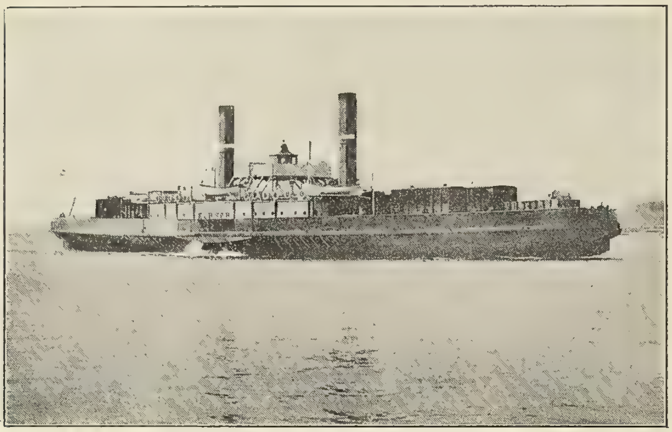


FIG. 2.—PADDLE-WHEEL FERRY KORSOER.

kept in reserve for hard winter service, viz.: the *Christian IX., Prinsesse Alexandrine, Kjoebenhavn* and *Jylland.* Besides these ferries and those kept in reserve for extra hard winter service there are the four powerful ice-breaking steamers *Staerkodder, Mjoelnir, Thor* and *Thyr,* of 553, 497, 497 and 518 gross tons and 600, 800, 800 and 800 indicated horsepower, respectively, but as they are not designed for carrying cars they are omitted here.

The twin-screw, double-track ferry *Christian IX.,* plying on the Korsoer-Nyborg route, is the government's latest addition to its ferry fleet. As she was built during the year 1908 she represents all the newest improvements, and appears as a very handsome and well fitted vessel. The trial trip took place on Oct. 20, and, having finished this to the highest satisfaction, the ferry went into commission. She is built of steel to the highest class Bureau Veritas, with extra strengthening

FIG. 3.—MAP OF DENMARK, SHOWING FERRY CROSSINGS AND PRINCIPAL RAILROAD LINES BELONGING TO THE GOVERNMENT.

for resisting ice. She is 290 feet long between perpendiculars, with a breadth of 39 feet 6 inches, and a depth of 18 feet 7 inches. The frames are 6 by 3 by 14/32-inch angles for a half length amidships, reduced to 6 by 3 by 12/32-inch bulb angles at the ends. They are spaced 25 inches apart. In the engine and boiler rooms deep frames, consisting of 8 by 3 by 16/32-inch bulb angles are fitted. There are no web frames used. The reverse frames are 3 by 3 by 11/32-inch angles, and where these are not fitted a 3-inch flange is turned on the

FIG. 4.—ICE-BREAKING FERRY JYLLAND.

floors. The reverse frames under the engines and boilers are single angles, 5 by 3½ by 18/32 inches, extending to the lower turn of the bilge. The floors are 23 inches wide, and in the engine and boiler rooms 15/32 inch thick; elsewhere they are 15/32 inch thick reduced to 11/32 at the ends.

No double bottom is fitted, but wing tanks are provided in the boiler room on each side, containing about 60 tons of water ballast each for trimming the vessel when unevenly loaded, the amount of ballast being controlled by a powerful centrifugal pumping plant in the after stokehold. Seven watertight bulkheads, extending to the main deck, divide the hull into eight watertight compartments. Steering is accomplished by means of two steam-operated rudders, the after one being balanced, and the transom here cut away in order to facilitate

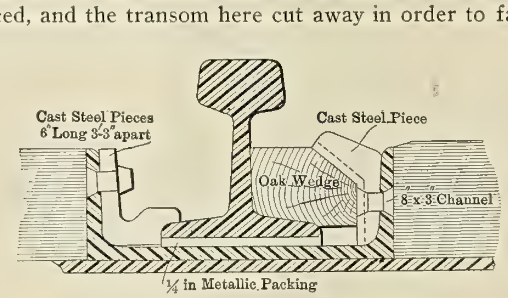


FIG. 5.—DETAIL OF RAIL FASTENING ON FERRY CHRISTIAN IX.

the turning of the rudder. The forward one is of the ordinary bow rudder type.

As may be seen from the body plan, the hull is very well designed to provide for speed, stability and easy motion, and like all these ferries the deck sheer is only slight, corresponding with the camber of the beams. The center line of the deck is thus straight. As on all other ferries a heavy, double wooden fender is carried all round the deck outboard, just fitting the shape of the ferry berths.

The drawings show clearly the general arrangement of accommodations. As the Danish trains carry three different class coaches on the longer routes, the ferries are arranged in the same manner, having one accommodation for the first and second classes and one for the third. On this boat pro-

vision is made for the first and second classes aft, and for the third class forward under the main deck. Of the open decks, saloons are provided both fore and aft, as the Danish trains never run with dining cars, because long trips are always

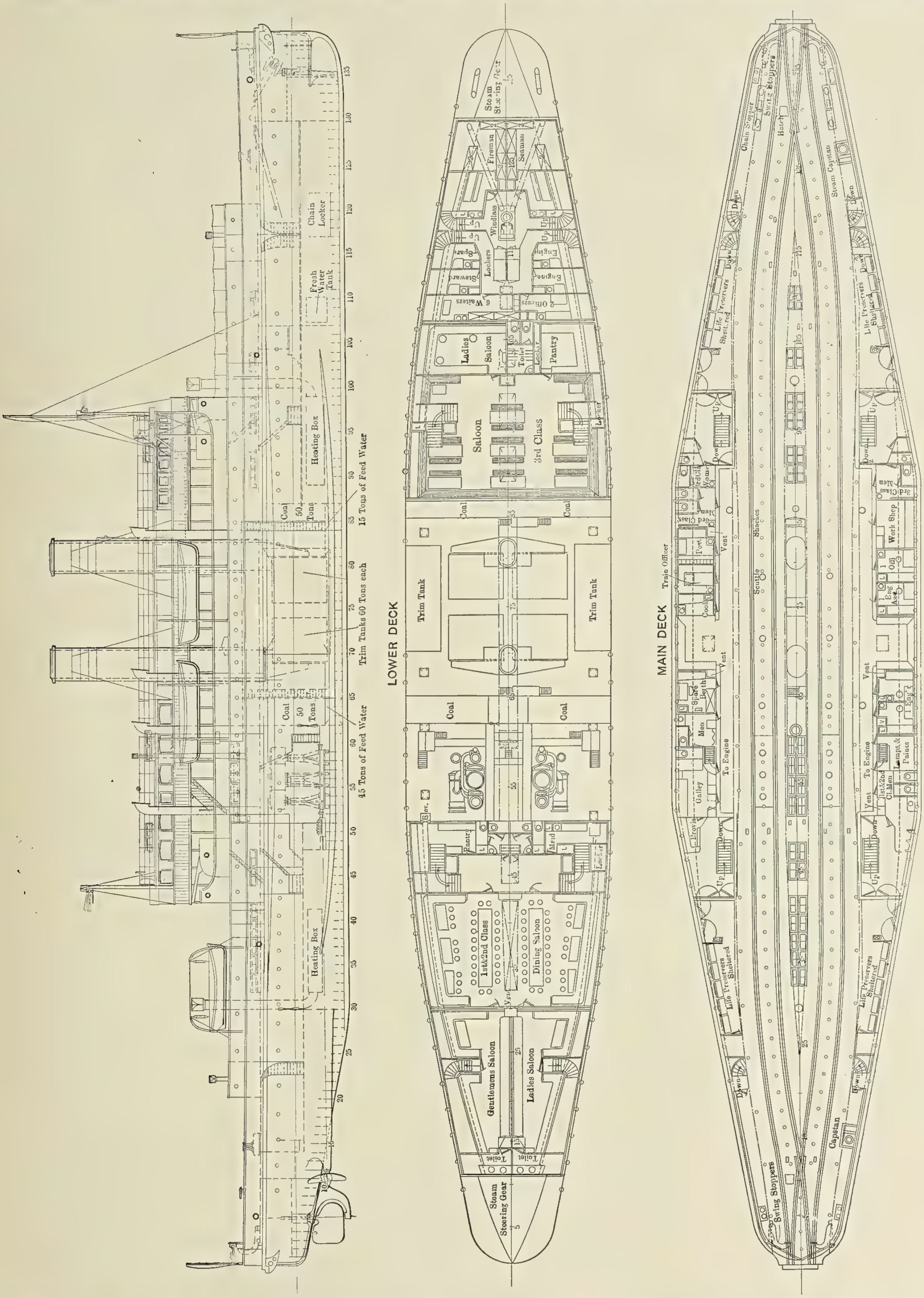


FIG. 6.—PROFILE AND DECK PLANS OF TWIN-SCREW FERRY CHRISTIAN IX.

the upper one is laid out for first and second-class use, and the main and side-house decks for third class. Large dining interrupted by a ferry crossing, where there is a better opportunity for dining on the boat. Of the after saloons the most

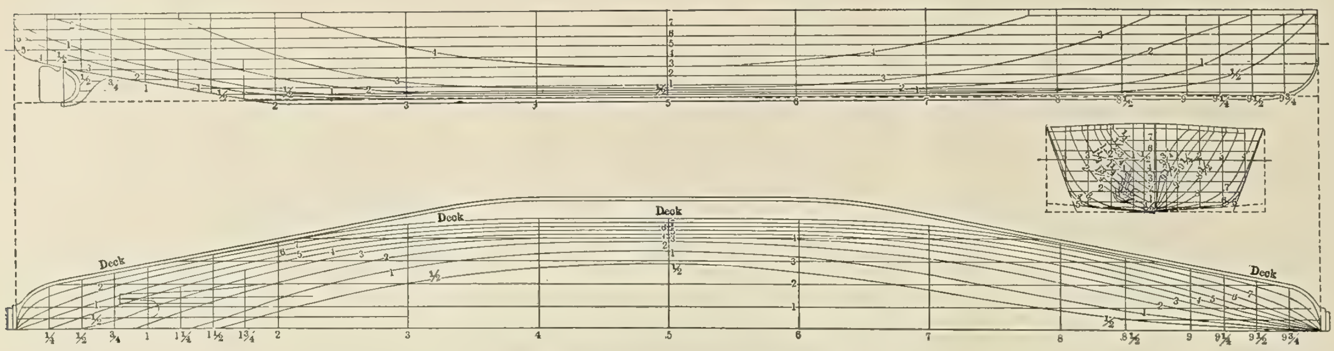


FIG. 7.—LINES OF THE CHRISTIAN IX.

important are the ladies' and gentlemen's parlors, finished in white enamel and gilt, and the dining saloon, capable of seating 84 persons, finished in carved and polished birch wood and gilt and figured leather. The third-class saloons forward are oak-painted with white ceilings. The two saloons on the upper promenade deck are finished in polished mahogany.

At the bow and stern are heavy steel shelves extending from the hull, as may be seen, to take the pads of the bridges in the ferry berths, and here the steel bulwark is cut away to leave a clear space for car shipment. Wooden bulkheads are substituted at these points. Heavy cast-steel stoppers are arranged at the ends to secure the train from accidentally running overboard, and they are made to swing out of the way when in harbor. Furthermore, there are shackles embedded in the wooden main deck alongside and between the tracks to take turnbuckles for tethering the cars. The rails themselves are wedged in channel bars, as shown on the sketch, to provide noiseless and soft running under shipment.

This ferry will probably be the future standard type for two-track ferries in the trade between Copenhagen and Malmoe and Korsoer-Nyborg. The ferry *Kjoebenhavn* (Fig. 9) may be regarded as the type formerly used for these ferries, covering the vessels *Kjoebenhavn, Korsoer, Nyborg, Sjaelland* and *Store-Baelt.* They are all paddle steamers, built during the years 1883-1900.

The *Kjoebenhavn* is built entirely of steel and under the same conditions as the *Christian IX.* She has neither double bottom nor wing tanks (this being arranged on the ferry *Sjaelland* by elongation of the vessel), but she is divided by four watertight bulkheads. The body of the ferry is symmetrical about the 'midship section, as are the general arrangements, the wheels being just in the center of the boat. Fore and aft rudders are arranged, both being of the bow-rudder type, and the transoms, fore and aft, are cut away. The arrangement of stoppers and movable bulwarks at the ends is similar to that described for the *Christian IX.* Of course this drawing shows the former kind of stoppers, consisting of heavy wooden booms, to be raised on taps at one end, but now this and all other ferries are furnished with the cast steel swing stoppers, which give at least 15 feet more

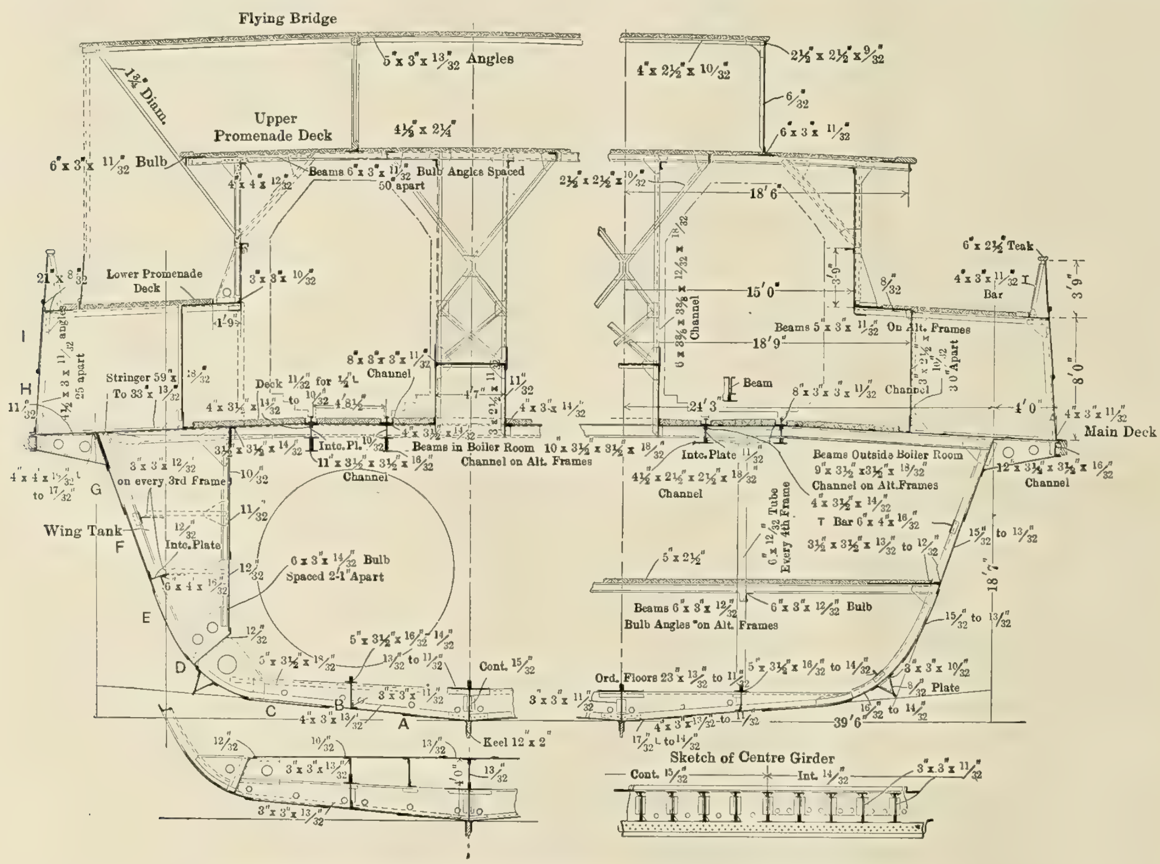


FIG. 8.—MIDSHIP SECTION OF THE CHRISTIAN IX., SHOWING PRINCIPAL SCANTLINGS.

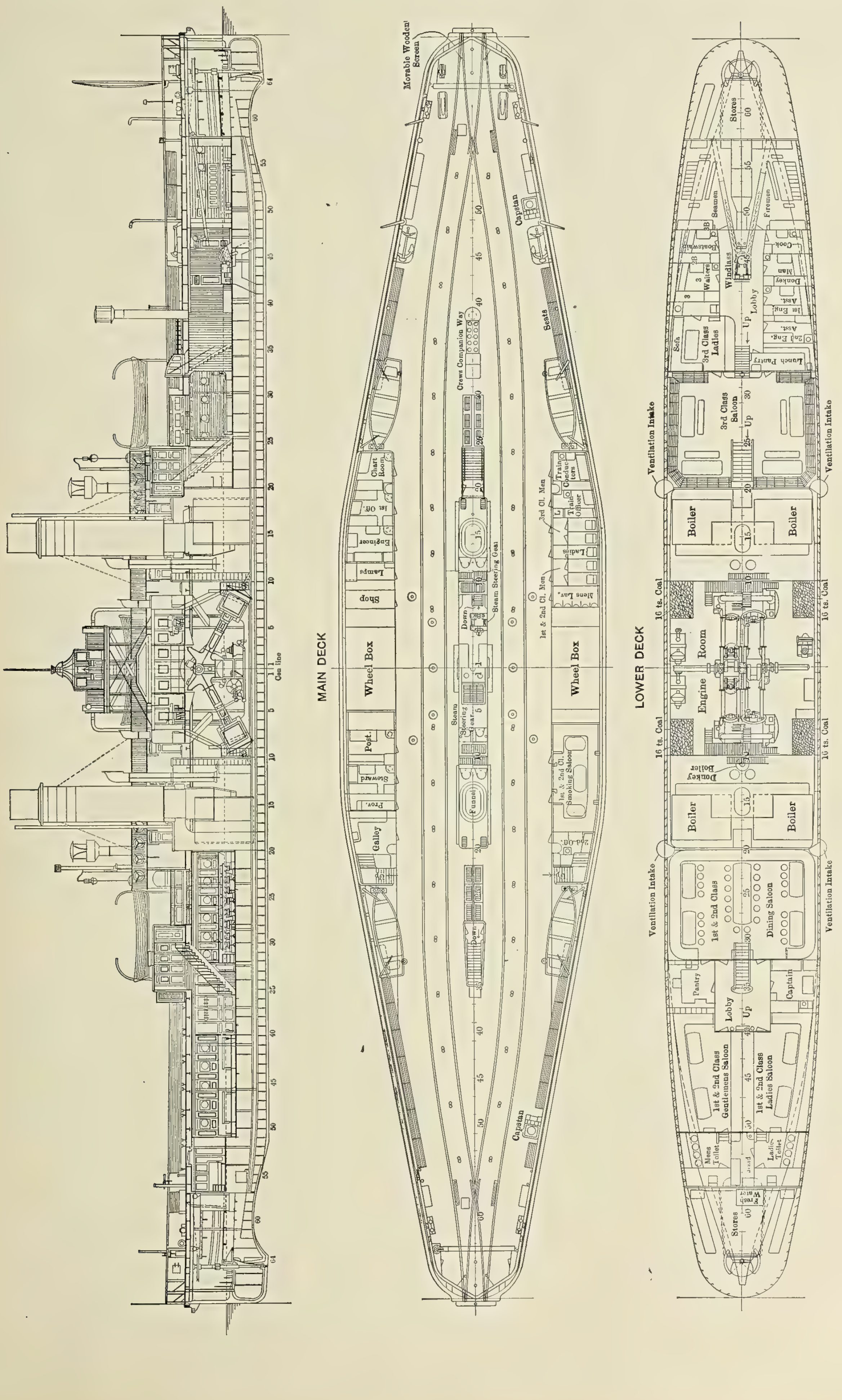


FIG. 9.—PROFILE AND DECK PLANS OF PADDLE-WHEEL FERRY KJOEBENHAVN.

useful length of track. Furthermore, there are steel shelves like those on the former ferry at the ends.

The steel paddle steamer *Strib* is a good example of the larger type of single-track ferries. She is much like the *Kjoebenhavn,* having the same symmetrical body and arrangement of stoppers and rudders fore and aft, and having the navigating bridge resting in the same manner on beams arched from side-house to side-house. The elongation adding 40 feet to the hull 'midship of this ferry has, however, done away with the symmetry of the general arrangement, thus moving the wheels, engine accommodations and bridge aft, and giving both of the bow-rudder type. No double bottom is arranged, but forward and aft and in both sides of the boiler room, besides in the wheel boxes and on the main deck, are ballast tanks for trimming purposes. The hull is divided into seven watertight compartments by six bulkheads, extending to the main deck. These boats differ from those previously described in the shape of hull at the ends and in the arrangements for closing in the bow. The deck lines on these ferries are wedge-like instead of being semi-circular as on the others, but the same steel shelves for taking the car-landing bridge at the docks are fitted in both ends. The side-housings are

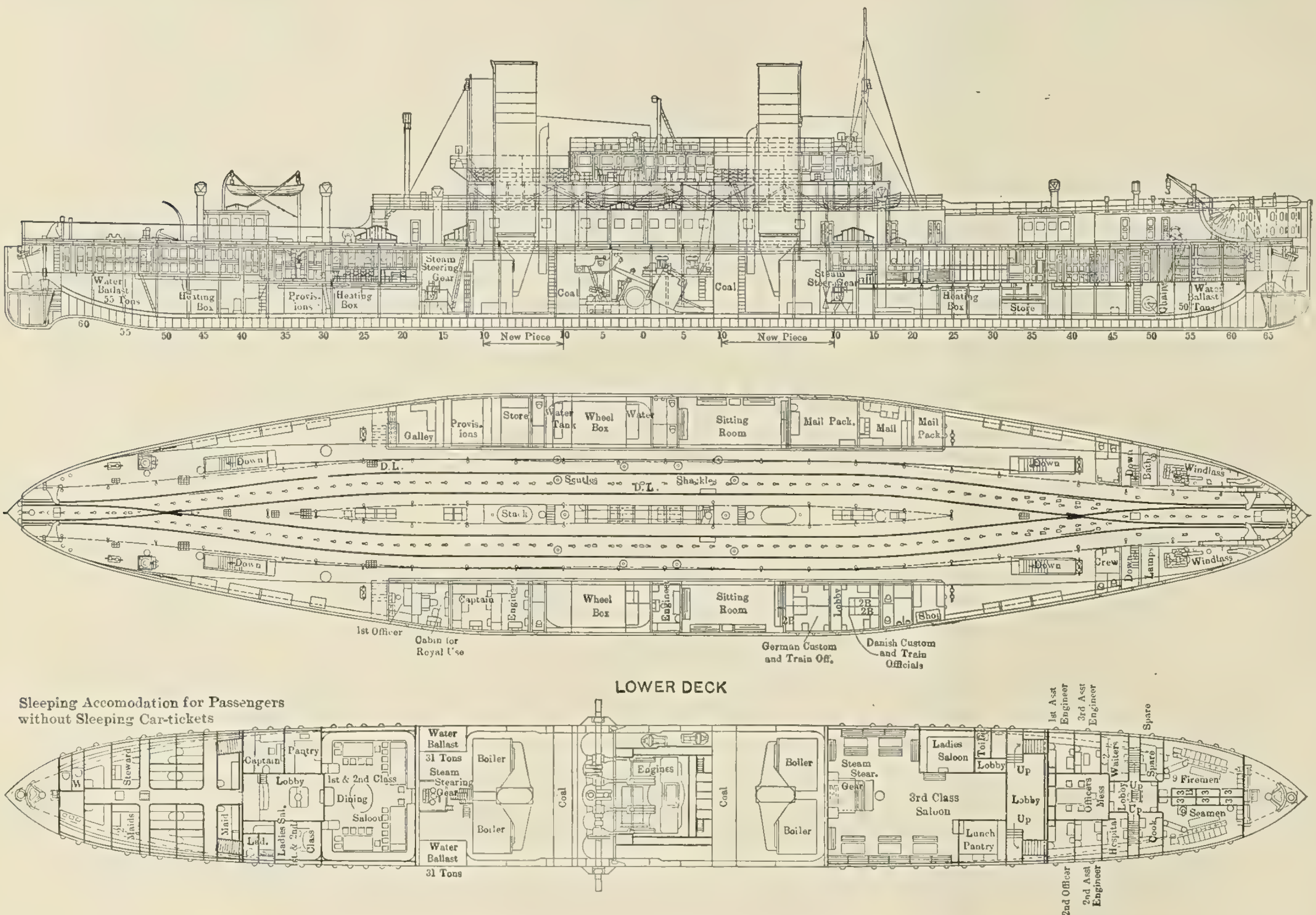


FIG. 10.—PROFILE AND DECK PLANS OF BALTIC FERRY PRINSESSE ALEXANDRINE.

space forward under the main deck for an additional third class saloon and a large ballast tank for 65 tons of water in the bottom.

All the vessels so far mentioned are ferries intended only for navigation on sheltered waters, and consequently they show many similarities in appearance and construction. On the Baltic, between Gjedser and Warnmünde, the ferries *Prins Christian* and *Prinsesse Alexandrine* are used, besides two other ferries under the Meclenburg flag, differing much from the other types. The *Prins Christian* is a twin-screw steamer, and the *Prinsesse Alexandrine* (Fig. 10) is a paddle wheeler. She was built in 1903 as a single-track ferry, with four smokestacks, but in 1905 an elongation and rebuilding was found necessary, owing to the rapid and unexpected increase of the traffic on this route. She now appears as a two-tracker with only two smokestacks. Furthermore, the hull before lengthening was symmetrical about the 'midship section, with the wheels just at the center of the ship and the transoms cut away both fore and aft, but now 23 feet are put in the body forward of the wheels and 16 feet aft, and the forward transom is filled in again. The rudders are as before, carried full height clear to the bow, to provide protection against the seas, and the entire fore part is so constructed that it can be raised about an athwartship horizontal axis, forming a sort of portal when raised, and allowing the cars to be shipped under it. The raising and lowering of this part is done by means of worms driven by steam engines underneath the main deck forward. The stopping arrangement at the stern is like that on the other ferries.

The *Jylland,* shown in Fig. 4, is a good type of the ice-breaking ferries used in winter time. She is 184 feet long over all, with a molded beam of 36 feet, a depth of 19 feet 2 inches, and at a draft of 16 feet 4 inches displaces 1,048 tons. Propulsion is by means of a compound engine with cylinders 30 and 57 inches in diameter, with a stroke of 33 inches. At 90 revolutions per minute and a steam pressure of 64 pounds per square inch, the total indicated horsepower is 800. Under these conditions the vessel is capable of maintaining a speed of 11.3 knots. Steam is furnished by two three-furnace single-ended Scotch boilers, having a total heating surface of 3,238 square feet and a grate area of 113 square feet; 1,760 pounds of coal are burned per hour, and the total bunker

capacity is 112 tons, distributed in two wing bunkers and one athwartship bunker. This is a double-track ferry. On the lower deck aft are the first and second class dining saloons, ladies' cabin and the officers' quarters. Forward, on the same deck, are the third class dining saloon, third class ladies' cabin, crew's and engineers' quarters.

TABLE I.

EXTRACT FROM THE DANISH GOVERNMENT'S RAILROADS.

Official Account of the Year 1905–1906.

Name of Crossing.	Date of Opening.	Distance at Crossing Miles.	Number of Double Trips a Year.			Number of Passengers a Year.			Tons of Goods Carried a Year.			Tons of Coal Used, 1905–1906.
			1895–1896.	1900–1901.	1905–1906.	1895–1896.	1900–1901.	1905–1906.	1895–1896.	1900–1901.	1905–1906.	
Fredericia-Strib	Mar. 1, 1872.	2.0	7,643	12,577	12,493	230,630	499,200	570,800	149,127	273,843	368,752	3,165.3
Gjedser-Warnemunde	Oct. 1, 1903	48.0	......	......	640*	......	......	*44,100	.....	......	*53,650	7,300.6
Glyngoere-Nykoebing	Oct, 1, 1889	2.5	1,581	2,183	2,266	35,137	48,200	57,200	13,017	20,090	25,612	959.3
Elsinore-Helsingborg	Mar. 10, 1892	3.0	2,310	3,078	3,456	169,339	287,400	405,600	74,859	95,884	113,051	1,867.8
Copenhagen-Malmoe	Oct. 5, 1895	18.5	329	795	**647	2,627	27,700	**38,000	5,513	123,910	**82,500	3,464.2
Korsoer-Nyborg	Dec. 1, 1883	16.0	2,333	4,062	4,243	213,713	496,400	571,000	133,670	280,773	349,240	18,275.7
Madsnedoe-Orehoved	Jan. 15, 1884	2.5	2,785	3,740	4,715	98,421	157,900	218,000	44,679	73,934	169,637	2,093.0
Oddesund	June 23, 1883.	2.0	1,999	2,623	2,184	33,486	47,000	55,400	27,777	39,455	51,220	648.2

* Traffic shared with the Mecklenburg Government, only ½ traffic stated here.
** Traffic shared with the Swedish Government, only ½ traffic stated here.

TABLE II.

Name of Ferry.	Lengths.		Breadth.		Depth.	Draft.	Displacement, Tons.	Tonnage.		Speed, Knots.	Nos. Boilers.	Nos. Fires.	Heating Surface, Sq. Ft.	Grate Area, Sq. Ft.	Pressure, Lbs., per Sq. In.	Bunker Capacity, Tons.	Lbs. of Coal Burned per Hour.	Engines.						Total I H.P.
	Over All.	On L.W.L.	Molded.	Over Guards.				Gross.	Net.									No.	Cylinder Diameters, Inches.			Stroke.	Rev. per Min.	
Christian IX	293′ 9″	290′ 0″	48′ 6″	58′ 0″	18′ 7″	12′ 6″	2,600*	......	......	13.0	4	12	7,750	215	185.0	100*	......	2	...	...	...	..	...	1,800
Prinsesse Alexandrine	333′ 6″	333′ 6″	36′ 0″	61′ 6″	18′ 9″	12′ 6″	2,425	1,733.4	676.6	13.8	4	12	7,755	215	185.0	130	3,325	1	31½	52	82½	63	36	2,140
Prins Christian	284′ 9″	281′ 0″	41′ 6″	57′ 9″	22′ 6″	14′ 5″	2,065	1,824.0	686.0	13.75	4	12	7,557	213	185.0	112	3,740	2	19	31½	52	28	124	2,200
Korsoer	252′ 6″	250′ 0″	34′ 0″	58′ 0″	16′ 0″	9′ 6″	1,267	971.0	436.0	12.25	4	12	5,290	180	79.5	56	2,640	2	33¾	63	...	54	33	1,200
Nyborg	253′ 6″	250′ 0″	34′ 0″	58′ 0″	16′ 0″	9′ 6″	1,267	971.0	436.0	12.25	4	12	5,290	180	79.5	56	2,640	2	33¾	63	...	54	33	1,200
Sjaelland	293′ 6″	290′ 0″	34′ 0″	58′ 0″	16′ 9″	9′ 3″*	1,282*	975.0*	440.0*	12.25*	4	12	5,190	143	89.5	56	2,860	2	34	62	...	54	36	1,300
Kjoebenhavn	278′ 0″	272′ 0″	34′ 0″	58′ 0″	16′ 9″	10′ 0″	1,455	1,091.0	425.0	12.5	4	12	5,190	143	89.5	56	2,750	2	34	62	...	54	36	1,230
Store-Baelt	278′ 6″	272′ 6″	34′ 6″	58′ 0″	16′ 9″	10′ 4″	1,462	1,114.0	431.0	12.5	4	12	5,380	178	89.5	56	2,860	2	34	62	...	54	34	1,250
Alexandra	207′ 6″	206′ 0″	26′ 0″	44′ 0″	12′ 9″	7′ 9″	725	490.0	269.0	10.0	2	4	1,928	64	79.6	21	990	1	32	60	...	45	38	440
Thyra	207′ 6″	206′ 0″	26′ 0″	44′ 0″	12′ 9″	7′ 9″	725	490.0	269.0	10.0	2	4	1,928	64	79.6	32	990	1	32	60	...	45	38	440
Dagmar	209′ 0″	206′ 3″	26′ 0″	43′ 0″	12′ 6″	7′ 6″*	720*	480.0*	265.0*	10.0*	2	4	1,857	59	79.6	30*	880	1	32	60	...	45	35	380
Strib	204′ 6″	203′ 0″	26′ 0″	44′ 0″	12′ 9″	7′ 6″*	720*	475.0*	263.0*	10.0*	2	4	1,919	57	79.6	20*	990	1	29	56	...	45	35	400
Helsingborg	180′ 0″	177′ 0″	32′ 0″	43′ 0″	14′ 6″	10′ 3″	720	530.0	187.0	10.0	2	4	2,497	71	119.4	20	1,210	2	19	38	...	20	138	630
Kronprinsesse Louise	209′ 0″	206′ 0″	26′ 0″	44′ 0″	12′ 9″	8′ 6″	665	513.0	285.0	10.0	2	4	1,929	63	79.6	44	1,012	1	32	60	...	45	35	420
Kronprins Frederik	180′ 0″	176′ 6″	26′ 0″	44′ 0″	12′ 9″	8′ 7″	576	414.0	170.0	10.0	2	4	1,929	63	79.6	21	1,012	1	29	54	...	45	33	400
Marie	204′ 6″	199′ 3″	31′ 6″	43′ 0″	13′ 0″	9′ 0″*	950*	500.0*	250.0*	10.0*	3	6	3,200	93	79.6	45*	1,650	2 1	21½ 23½	36½ 44	... ...	18 18	125 150	550 500*
Valdemar	144′ 0″	140′ 0″	31′ 6″	43′ 0″	13′ 0″	9′ 0″	550	361.0	129.0	10.0	2	4	2,132	62	79.6	28	1,100	2	21½	36½	...	18	134	575
Jylland	184′ 0″	180′ 0″	36′ 0″	48′ 0″	19′ 2″	16′ 4″	1,048	716.0	253.0	11.3	2	6	3,238	113	64.0	112	1,760	1	30	57	...	33	90	800
Lille Baelt	140′ 6″	139′ 0″	26′ 0″	44′ 6″	11′ 6″	8′ 0″	399*	306.0	125.0	8.0	2	4	1,857	68	25.6	25¼	1,100	1	36	36	...	45	34	280
Fredericia	140′ 6″	138′ 6″	26′ 0″	44′ 6″	11′ 6″	7′ 3″	390	304.0	132.0	8.0	2	4	1,857	69	30.0	25¼	1,100	1	36½	36½	...	45	32	280
Hjalmar	168′ 9″	167′ 0″	26′ 0″	44′ 0″	12′ 0″	7′ 0″	440	332.0	124.0	10.25	2	4	1,857	59	79.6	21	920	1	32	60	...	45	37	400
Ingeborg	168′ 9″	167′ 0″	26′ 0″	44′ 0″	12′ 0″	7′ 0″	440	343.0	136.0	10.25	2	4	1,857	59	79.6	21	920	1	32	60	...	45	37	400

* About.

TABLE III.

Name of Ferry.	Type.	Where and When Built.	Where Engaged.
Christian IX.	Twin screw, double track.	Burmeister & Wain, Copenhagen, 1908.	Korsoer-Nyborg.
Prins. Alexandrine	Paddle wheel, double track.	Schichaus' Yard, Elbing, 1903.	Gjedser - Warnemunde.
Prins. Christian.	Twin screw, double track.	Elsinore's Shipyard, 1903.	Gjedser - Warnemunde.
Korsoer.	Paddle wheel, double track.	Kochum's Yard, Malmoe, 1883.	Korsoer-Nyborg.
Nyborg.	Paddle wheel, double track.	Kochum's Yard, Malmoe, 1883.	Korsoer-Nyborg.
Sjaelland.	Paddle wheel, double track.	B. & W., Copenhagen, 1887.	Korsoer-Nyborg.
Kjoebenhavn.	Paddle wheel, double track.	B. & W., Copenhagen, 1895.	Copenhagen-Malmoe.
Store-Baelt.	Paddle wheel, double track.	B. & W., Copenhagen, 1900.	Korsoer-Nyborg.
Alexandra.	Paddle wheel, single track.	B. & W., Copenhagen, 1892.	Madsnedoe - Orehoved.
Thyra.	Paddle wheel, single track.	B. & W., Copenhagen, 1893.	Madsnedoe - Orehoved.
Dagmar.	Paddle wheel, single track.	B. & W., Copenhagen, 1889.	Madsnedoe - Orehoved.
Strib.	Paddle wheel, single track.	Elsinore, 1901.	Fredericia-Strib.
Helsingborg.	Single F. and aft screw, single track.	Elsinore, 1902.	Elsinore - Helsingborg.
Kronprinsesse Louise.	Paddle wheel, single track.	Elsinore, 1891.	Elsinore - Helsingborg.
Kronprins Frederik.	Paddle wheel, single track.	Elsinore, 1898.	Elsinore - Helsingborg.
Marie.	2 screws aft, 1 screw forward, single track.	B. & W., Copenhagen, 1890.	Madsnedoe Orehoved.
Valdemar.	single screw, single track, icebreaker.	B. & W., Copenhagen, 1886.	Reserve.
Jylland.	single screw, single track, icebreaker.	B. & W., Copenhagen, 1894.	Reserve.
Lille Baelt.	Paddle wheel, single track.	Richardson, Newcastle, 1872.	Fredericia-Strib.
Fredericia.	Paddle wheel, single track.	Shichau, Elbing, 1877.	Fredericia-Strib.
Hjalmar.	Paddle wheel, single track.	Shichau, Elbing, 1883.	Glyngoere - Nykoebing.
Ingeborg.	Paddle wheel, single track.	Shichau, Elbing, 1883.	Oddesund.

THE RIVETED JOINTS OF CYLINDRICAL BOILERS.

BY H. K. SPENCER, CHIEF ENGINEER U. S. R. C. S.

Assume that the diameter of the boiler shell has been determined and the quality of the material to be used in its construction has been selected, and all the necessary data are at hand for designing the riveted joints of the boiler. Only those joints commonly used in cylindrical boilers will be discussed; they are the single, double and triple riveted lap joints, and the double and triple riveted, double butt-strapped butt joints.

Let

P = working pressure in pounds per square inch,

R = inside radius of cylindrical shell in inches,

t = thickness of shell in inches, and

T = tensile strength of material in pounds per square inch of section.

The total pressure tending to burst the cylindrical shell of the boiler longitudinally is, if the length of the shell is 1 inch, $2 \times R \times 1 \times P$, which is resisted by two sections of metal each 1 inch long and t inch thick, having a tensile strength T pounds per square inch, so the equation can be written,

$2 \times R \times 1 \times P = 2 \times 1 \times t \times T$, and $R\ P = T\ t$......(1.)

The pressure tending to tear the shell apart circumferentially is $P \pi R^2$, which is resisted by a section of metal of $2\pi\ (R + 1/2t)\ T$ square inch, so $P \pi R^9 = 2\pi\ (R + 1/2t)\ T$, and $R\ P = 2tT\ (1 + t2R)$............................(2.), from which it is seen that a boiler is a little more than twice as strong circumferentially as it is longitudinally.

To obtain the maximum economy of material in a riveted joint it should be so proportioned that it will be no more liable to rupture by the tearing apart of the plate than by the shearing of the rivets, or by the failure of the plate or rivets by crushing. In lap joints and butt joints with single butt straps the rivets are in single shear, while in butt joints with double butt straps they are in double shear. The shearing strength of rivet steel is about 0.8 of its tensile strength, and the strength of a rivet in double shear is considered to be 1.8 times the strength of the same rivet in single shear. Steel is used almost entirely for boiler construction.

$T = 60{,}000$ pounds per square inch,
$S = 48{,}000$ pounds per square inch, shearing strength of rivets, and
$C = 66{,}000$ pounds per square inch, strength of plate and rivets in compression.

A factor of safety of 4.5 is sufficient to insure bringing the working strength well within the elastic limit of the material.

Equation (1.) shows that the strength, longitudinally, of a plain cylindrical shell to resist a bursting pressure is independent of its length, so a girth strip of length equal to the pitch of the rivets can be considered. Let
p = the pitch of the rivets in inches, and
d = the diameter of the rivets in inches.

From equation (1.), the strength, longitudinally, of a cylindrical shell, made with a perfectly welded joint, is expressed by

$p\,R\,P = T\,p\,t$, and $t = R\,P/T$..................(3.)

Any riveted joint is weaker than the plate, because a certain amount of the material of the plate must be cut out for the line of rivets, so the thickness must be greater than that of the cylindrical shell, perfectly welded.

SINGLE LAP RIVETING.

The single riveted lap joint is the simplest, but it is never used except for joints exposed to the fire, where tightness only is essential in the seam, and for the girth seams of boilers of small diameter, for moderate working pressures. To show the low efficiency of this style of joint, suppose the longitudinal seam of a boiler to be a single riveted lap joint. The inside diameter of the shell is taken as 72 inches, and the working pressure as 80 pounds per square inch. Referring to Fig. (1.), and considering a ring of width (p), it is seen that the plate, at the line of rivets, has a section of $(p - d)\,t$ square inch and the strength of the shell, in tension, then is, from equation (1),

$p\,R\,P = 60{,}000\,(p - d)\,t$......................(4.),

and the strength to resist shearing is

$p\,R\,P = 48{,}000\pi d^2/4$..........................(5.),

and the resistance to crushing is, taking the projected area of the rivet as the area of rivet and plate in compression,

$p\,R\,P = 66{,}000\,d\,t$............................(6.)

It is seen that all these expressions are equal, therefore, combining (4) and (6) gives

$60{,}000\,(p - d)\,t = 66{,}000\,d\,t$, and $p = 2.1\,d$......(7.)

The efficiency of the joint is

$[(p - d)\,/p] \times 100 = [(2.1d - d) \div 2.1d] \times 100 = 52.38$ percent.

Combining (5) and (6) gives

$48{,}000\pi d^2/4 = 66{,}000\,dt$, and $t = 0.5712\,d$........(8.)

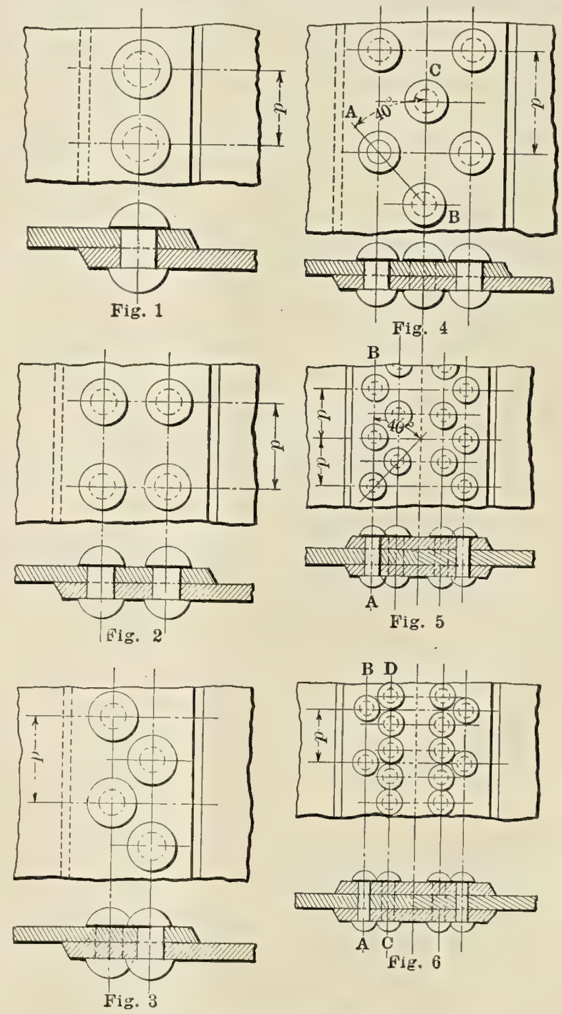
For the 72-inch boiler, the value of d can be found from equation (6) by substituting in it the values of p from (7), and t from (8), and the known quantities R and P, and introducing the factor of safety, 4.5. Then

$2.1\,d \times 36 \times 80 = (66{,}000/4.5) \times 0.5712\,d^2$.

$d = 0.7219$ inch.
$t = 0.5712\,d = 0.4124$ inch.
$p = 2.1\,d = 1.516$ inch.

DOUBLE LAP RIVETING.

The double-riveted lap joint is frequently used for the longitudinal seams of boilers of small diameter and moderate working pressures and for the girth seams of large boilers to carry high pressures. For comparison with the single riveted lap joint, suppose the longtitudinal seam of the boiler under consideration to be a double-riveted lap joint. The riveting may be arranged either as in Fig 2, called chain riveting, or as in Fig. 3, called staggered or zigzag riveting; the latter is generally used, as it gives the same strength as chain riveting, with less material in the lap.



LAP AND BUTT JOINTS.

As before, consider a ring of width equal to the pitch of the rivets. For tensile strength, equation (4) is used unmodified, and $p\,R\,P = 60{,}000\,(p - d)\,t$.

In this joint there are two rivets to take the shearing and crushing stresses, so equations (5) and (6) are modified, respectively, to

$p\,R\,P = 48{,}000 \times 2\pi d^2/4$....................(9.)
$p\,R\,P = 66{,}000 \times 2d\,t$........................(10.)

Combining (4) and (10) gives

$60{,}000\,(p - d)t = 66{,}000 \times 2\,d\,t$, and $p = 3.2\,d$.(11.)

The efficiency is $(3.2d - d)\,/\,3.2d \times 100 = 68.75$ percent.

Similarly, combining (9) and (10) gives

$48{,}000 \times 2\pi d^2/4 = 66{,}000 \times 2\,d\,t$, and $t = 0.5712\,d$..(12.)

Substituting the values of p and t, as given by equations (11) and (12), in equation (10) gives, using, as before, a

factor of safety of 4.5, $3.2d \times 36 \times 80 = (66{,}000 / 4.5) \times 2 \times 0.5712\ d^2$, and

$d = 0.5504$ inch,
$t = 0.5712\ d = 0.3142$ inch,
$p = 3.2\ d = 1.763$ inch.

TRIPLE LAP RIVETING.

In a triple-riveted lap joint, Fig. 4, there are three rivets in single shear, and three to take the crushing stress, so the equations for this style of joint are as follows: Equation (4),

$p\,R\,P = 60{,}000\ (p - d)\ t,$
$p\,R\,P = 48{,}000 \times 3\pi d^2/4$......................(13.)
$p\,R\,P = 66{,}000 \times 3\ d\ t$......................(14.)
combining (4) and (14) gives $p = 4.3\ d$........(15.)

The efficiency is $[(4.3d - d) / 4.3d] \times 100 = 76.74$ percent.

Combining (13) and (14) gives $t = 0.5712\ d$....(16.)

Substituting the values of p and t, as given by (15) and (16), in (14), introducing the factor of safety, 4.5, and the values of R and P, as used before, gives

$d = 0.4927$ inch,
$t = 0.5712\ d = 0.2815$ inch,
$p = 4.3\ d = 2.119$ inches.

In staggered riveting, the distance between the rows of rivets must be such that the plate will not tear obliquely between the rivets. Here the metal is subjected to a combined tension and shearing stress. By making the angle ABC, Fig. 3, about 40 degrees, sufficient strength is given and the distance between rows of rivets is about 0.42 p, as a minimum.

BUTT JOINTS.

For butt joints with single butt straps the same diameter of rivets, thickness of plate and pitch of rivets would be obtained as with lap riveting, though double the number of rivets would be used. The butt strap should be the same thickness as the plate.

DOUBLE BUTT STRAPS, DOUBLE RIVETING.

A double-riveted butt joint, with double butt straps, is shown in Fig. 5. Such seams can be used for the longitudinal seams of boilers of small diameter for moderate working pressures. It will be considered as applied to the 72-inch boiler for 80 pounds pressure, for comparison with the double-riveted lap joint.

It is evident that the section of plate along the line AB is the one to be considered in calculating the tensile strength, and the section of plate in tension is $(p - d)\ t$. Each rivet presents two sections to resist shearing. Putting the shearing strength equal to the crushing strength gives an equation similar to (12), but in this case the rivets are in double shear, and hence have a value 1.8 times that given by (12), and

$t = 0.5712\ d \times 1.8 = 1.028\ d$...................(17.)

As was done with the lap joints, the tensile strength of the plate section can be placed equal to the strength of the rivets or plate in compression, and equations (4) and (10) hold true here, so $p = 3.2\ d$, and the efficiency is the same as for double lap riveting, 68.75 percent.

Substituting as before, and using the same factor of safety, gives $3.2\ d \times 36 \times 80 = (66{,}000 / 4.5) \times 2 \times 1.028\ d^2$, and

$d = 0.3056$ inch.
$t = 0.3142$ inch,
$p = 0.9778$ inch.

It is seen that, while this joint gives the same efficiency and thickness of plate as the double-riveted lap joint, it gives a different proportion of rivet diameter to plate thickness. For strength alone the butt straps need be only one-half as thick as the plates, but for tightness and rigidity they are made equal to three-fourths of, or to the plate thickness. The angle ABC must not be less than 40 degrees.

The double-riveted, double but strapped joint, when used, should be made as in Fig. 6, with alternate rivets in the outer rows omitted. In this joint the pitch is taken as the distance between centers of the outer rivet holes; that is, along the line AB. The tendency to rupture must be no greater along the line CD than along the line AB. The section of plate at AB, to resist tension, is $(p - d)\ t$, and its strength is expressed by equation (4), while that along CD is $(p - 2d)\ t$, but the weaker section at CD is compensated for by the rivet sections in the outer row, which must be sheared by the bursting pressure, in addition to tearing the plate along the line CD. The total resistance to rupture along that line is expressed by the equation

$p\ R\ P = 60{,}000\ (p - 2d)\ t + 48{,}000 \times 1.8\pi d^2/4$. (18.)

For shearing, the strength is expressed by

$p\ R\ P = 48{,}000 \times 3 \times 1.8\pi d^2/4$................(19.)

For compression, the equation is the same as (14).

As all these expressions are equal,

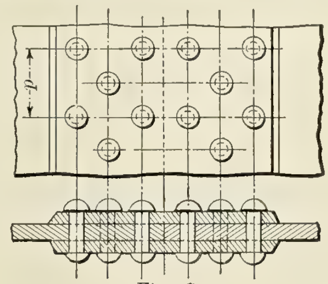


Fig. 7

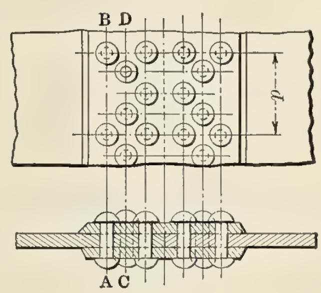


Fig. 8

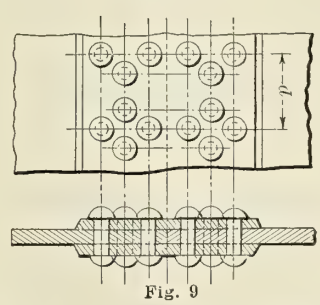


Fig. 9

$60{,}000\ (p - 2\ d)\ t + 48{,}000 \times 1.8\pi d^2/ 4 = 60{,}000\ (p - d)\ t$, which, rewritten, expresses the condition for equal strength along AB and CD as $60{,}000\ d\ t = 48{,}000 \times 1.8\pi d^2/4$..........................(20.)

$t = 1.131\ d$..................................(21.)

Equation (20) shows that the rivets in the outer rows must have a shearing strength equal to the amount by which the tensile strength of the plate at the inner row is reduced, by the additional rivet hole in that row.

Putting the tensile strength equal to the crushing strength, $60{,}000\ (p - d)\ t = 66{,}000 \times 3\ d\ t$, and

$p = 4.3\ d$..................................(22.)

The efficiency of the joint is the same as for the triple-riveted lap joint, 76.74 percent.

This style of joint is used for the longitudinal seams of boilers for moderately high working pressures. Suppose it to be used in a 72-inch boiler to carry 80 pounds pressure, then, using a factor of safety of 4.5,

$d = 0.2489$ inch,
$t = 0.2815$ inch.
$p = 1.071$ inches.

For a 12-foot boiler, to carry 120 pounds pressure,

$d = 0.7466$ inch,
$t = 0.8444$ inch,
$p = 3.197$ inches.

For a boiler 14 feet inside diameter, to carry 160 pounds,

$d = 1.161$ inch,
$t = 1.314$ inch,
$p = 4.994$ inches.

DOUBLE BUTT STRAPS, TRIPLE RIVETING.

Fig. 7 shows a triple-riveted, double butt strapped joint. Each section of width p presents three rivets in double shear to resist the shearing stress, and three to withstand crushing. Putting the tensile strength equal to the crushing strength gives $60{,}000\ (p - d)\ t = 66{,}000 \times 3\ d\ t$, from which,

$p = 4.3\ d$ ....(23.)

The efficiency is 76.74 percent.

There being three rivets in double shear, the proportion of t to d is the same as that expressed by equation (17), and

$t = 1.028\ d$ ....(24.)

For the 14-foot boiler for 160 pounds working pressure, the results are

$d = 1.278$ inches,
$t = 1.314$ inches,
$p = 5.497$ inches.

The efficiency and thickness of plate are the same as obtained with triple lap riveting and double butt riveting, omitting alternate rivets in the outer rows.

The triple-riveted, double butt strapped joint, when used for boilers to carry high pressures, is made with the alternate rivets in the outer rows omitted, as in Fig. 8. The pitch is taken as the distance between centers of rivets in the outer rows. Here for each pitch there are five rivets in double shear, and five to resist crushing. The joint must not be more liable to fail along CD than along AB, so here again the condition must be $60{,}000\ d\ t = 48{,}000 \times 1.8\pi d^2/4$, and $t = 1.131\ d$. (25.)

Equations, one similar to that from which (23) was derived, expressing equal strength along AB and CD, and one giving the strength in compression, can be written, and

$60{,}000 (p - 2d)\ t + 48{,}000 \times 1.8\pi d^2/4 = 60{,}000\ (p - d)\ t$
$= 66{,}000 \times 5\ d\ t$, and $p = 6.5\ d$ ....(26.)

The efficiency is 84.61 percent.

For a boiler 14 feet in diameter, to carry 160 pounds pressure,

$d = 1.053$ inches,
$t = 1.191$ inches,
$p = 6.846$ inches.

The triple-riveted joint is sometimes made, as in Fig. 9, with not only the alternate rivets in the outer rows omitted, but also the alternate ones in the inner rows. The condition, $60{,}000\ dt = 48{,}000 \times 1.8\pi d^2/4$, must also be kept here, and again, $t = 1.131\ d$.

There are four rivets in double shear and four in compression for each pitch, and $p = 5.4\,d$. The efficiency is 81.48 percent.

For the 14-foot boiler,

$d = 1.094$ inches,
$t = 1.237$ inches,
$p = 5.907$ inches.

The most efficient triple-riveted butt seam is obtained by the arrangement of rivets shown in Fig. 10, where the number of rivets per pitch is reduced by one in each row, outward from the butt. Here again the condition must be kept, that $60{,}000\ d\ t = 48{,}000 \times 1.8\pi d^2/4$, and $t = 1.131\ d$.

There are six rivets in double shear and six in compression in each strip of width p, which is the distance between rivet centers in the outermost row, and $p = 7.6\ d$, which makes the efficiency 86.84 percent.

For a 14-foot boiler, to carry 160 pounds,

$d = 1.003$ inches,
$t = 1.134$ inches,
$p = 7.622$ inches.

A form of triple-riveted butt joint is shown in Fig. 11. It is used for the longitudinal seams of locomotive boilers which have diameters as large as 84 inches and carry pressures up to 220 pounds per square inch. It is seen that in each strip of width p, which is taken as the distance between rivet centers in the outermost rows, there are four rivets in double shear and one in single shear, and that there are five rivets to resist crushing. The resistance to rupture along CD must equal that along AB; that is, the tensile strength of the plate at CD, plus the strength of the rivets in the outermost row in single shear, must be equal to the tensile strength of the plate along AB, or algebraically, $60{,}000\ (p - 2d)\ t + 48{,}000\pi d^2/4 = 60{,}000\ (p - d)\ t$, which imposes the condition, $60{,}000\ d\ t = 48{,}000\pi d^2/4$, and $t = 0.6283\ d$ ....(27.)

For equal strength to resist tearing, at AB or CD, shearing and compression, the equations can be written,

$60{,}000\ (p - 2d)\ t + 48{,}000\pi d^2/4 = 60{,}000\ (p - d)\ t =$
$66{,}000 \times 5\ d\ t$, and $p = 6.5\ d$ ....(28.)

The efficiency is 84.61 percent, the same as for the joint shown in Fig. 8.

For a 14-foot boiler for 160 pounds working pressure,

$d = 1.896$ inches,
$t = 1.191$ inches,
$p = 12.32$ inches.

For a locomotive boiler 78 inches inside diameter, to carry a working pressure of 200 pounds, the results are

$d = 1.103$ inches,
$t = 0.693$ inch,
$p = 7.169$ inches.

From equations (25) and (26), for the same boiler,

$d = 0.613$ inch,
$t = 0.693$ inch,
$p = 3.983$ inches,

and, if made as in Fig. 10,

$d = 0.5957$ inch,
$t = 0.6737$ inch,
$p = 4.527$ inches.

Made as in Fig. 11, with the narrow butt strap outside, a good calking edge is presented, with the minimum distance between rivets, so the arrangement not only gives high efficiency, but insures tightness, where comparatively thin plates are used. It is seen that such riveting would be impracticable for boilers of large diameters, for high pressures, because of the large diameter of rivet necessary.

Figs. 1 to 6, inclusive, are drawn to the same scale and show the results obtained by applying the different styles of riveting to a boiler 72 inches in diameter to carry 80 pounds pressure. Figs. 7 to 11, inclusive, are also drawn to the same scale, and are calculated for the 14-foot boiler. For convenient comparison, the results obtained by applying the different styles of riveting, as shown by Figs. 6 to 11, inclusive, to the longitudinal seams of a 14-foot boiler to carry a working

pressure of 160 pounds, are tabulated below. $2n$ = number of rivets per pitch. N = number of rivets in a seam 10 feet long. E = efficiency, percent.

FIGURE.	d.	t.	p.	2n.	N.	E
6	1.161	1.314	4.994	6	144	76.74
7	1.278	1.314	5.497	6	132	76.74
8	1.053	1.191	6.846	10	176	84.61
9	1.094	1.237	5.907	8	164	81.48
10	1.003	1.134	7.622	12	190	86.84
11	1.896	1.191	12.32	10	98	84.61

If, instead of using the riveting shown in Fig. 7 for the 14-foot boiler, that shown in Fig. 8 was used, a saving of 2,360 pounds in the weight of the shell would result, by using that shown in Fig. 9, 1,480 pounds, and by using that shown in Fig. 10, 3,450 pounds.

In general, it may be said that the efficiency of the double butt strapped joint can be indefinitely increased by increasing the number of rows of rivets, while decreasing the number of rivets in each row by one, outward from the butt of the plates.

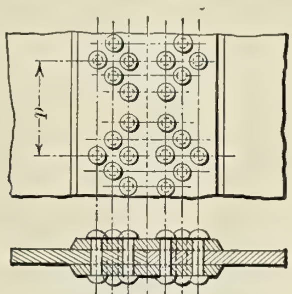


Fig. 10

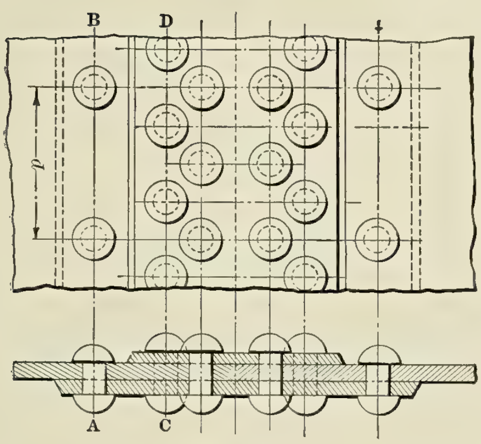


Fig. 11

Then, if the condition, $S \times 1.8\pi d^2/4 = T\ d\ t$, is maintained, the joint will be equally strong along each row of rivets, and the section plate at the outer row of rivets is the measure of the efficiency.

GENERAL RULES.

A quality of material, giving different values of T, S and C than those assumed by the writer, would often be used, so general expressions for t and p, in terms of d, are given. Let n equal one-half the number of rivets in a girth strip of width equal to the pitch.

For lap joints,

$t = 0.7854\ d\ S/C$, or $d = 1.273\ t\ C/S$..........(29.)

$p = (Cn - T)d/T$..........................(30.)

For butt joints with double straps, all rivets in double shear,

$t = 1.414\ d\ S/C$, or $d = 0.8903\ tC/S$...........(31.)

For double butt joints all rivets in double shear and alternate rivets in the outer rows omitted,

$t = 1.414\ d\ S/T$, or $d = 0.8903\ t\ T/S$...........(32.)

If the rivets in the outer rows are in single shear,

$t = 0.7854\ d\ S/T$, or $d = 1.273\ t\ T/S$..........(33.)

For the last three cases, the general expressions for the relations of p to d are the same as (30).

An extra 1/16 inch is usually added to the thickness of plate found by the formulæ, as an allowance for corrosion, so the designed pressure may be carried until the plates have lost that much in thickness.

GIRTH SEAMS.

The pressure acting to tear the boiler apart circumferentially is $P\ R$. Equations (1) and (2) show that the shell itself, as designed for strength longitudinally, is twice as strong as need be to resist rupture circumferentially, so, in the girth seams, the shearing strength of the rivets is all that need be considered. Assuming that the rivets in the girth seams are the same size as those in the longitudinal seams, and calling the total number of rivets in the seam (n_1), the equation for their shearing strength is

$P\pi R^2 = (48{,}000/4.5) \times n_1\pi d^2/4$, and $n_1 = 3\ P\ R^2/8{,}000d$. (34.)

The length of the seam to be riveted is $2\pi\ (R + t)$ inches, so, if n_2 is the number of rows of rivets in the seam, the pitch of the rivets will be

$p_1 = 2\pi n_2\ (R + t)\ /\ n_1$.......................(35.)

For a boiler 14 feet in diameter, to carry a working pressure of 160 pounds, $d = 1.053$ inches for the longitudinal riveting, if as in Fig. 8, and $n_1 = 382$, and then, from (35), using the proper value of t, $p_1 = 2.804$ inches, the girth seams being double-riveted lap joints.

CENTER OF RIVET TO EDGE OF PLATE.

In all riveting, the distance from the center of the rivet hole to the edge of the plate must be such that the plate in front of the rivet will not fail, as in Fig. 12, by tearing apart, and also there must be no possibility that the metal will shear out along the lines ab and cd. The latter will not occur in lap joints when $2\ l_1\ t\ S$ is greater than $\pi d^2 S/4$, or in double-strapped butt joints when $2\ l_1\ t\ S$ is greater than $1.8\pi d^2\ s\ /\ 4$

The metal directly in front of the rivet is subjected to a stress similar to that of a beam fixed horizontally at both ends,

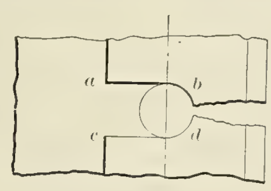


Fig. 12.

and loaded in the middle. The length of the beam is d, the diameter of the rivet; its depth is $l_1 - \frac{1}{2}\ d$, and its breadth is t. The load, which will be called P_1, is that tending to shear one rivet, and is equal to the load tending to rupture a ring of the shell of width equal to the pitch, so, if n is taken to represent the number of rivets in a lap joint, or one-half the number in a butt joint, for each strip of width p, $P_1 = p\ R\ P/n$. (36.)

From the equation for safe loading for a beam fixed horizontally at both ends, with a single load in the middle, calling the ratio, $t\ /\ d = n_3$, $l_1 = d\ /\ 2 + \sqrt{P_1\ /\ 16{,}000\ n}$ ....(37.)

or, substituting the value of (P_1),

$l_1 = d\ /\ 2 + \sqrt{p\ R\ P\ /\ 16{,}000\ n\ n_3}$.............(38.)

For the 14-foot boiler, with riveting as in Fig. 8, $d = 1.053$ inches, $t\ /\ d = 1.131$, $p = 6.846$ inches, and, substituting these values in (38), $l_1 = 1.52$ inches.

In calculating the stays for the flat surfaces in a boiler, it is not considered that the material in the surface supported has

any value in resisting the bursting pressure. Whenever possible the stays should be so spaced as to permit a man to pass between them; this can always be done with the through braces above the tubes, where the plates can be reinforced by large washers riveted to the plates supported. Here the pitch is seldom greater than 16 inches. Calling the pitch of the stays p^2, the load each stay supports is $p^2_2 \times P$, P being the boiler pressure. Each square inch of net section of the stay should safely support a working load of 10,000 pounds (working stress allowed by Lloyds), so, calling the diameter of the stay d_2, the equation for its strength is

$$p^2_2 P = 10{,}000 \pi d^2_2/4, \text{ and } d_2 = .0113\, p_2 \sqrt{P} \ldots\ldots (39.)$$

Let $p_2 = 16$ inches and $P = 160$ pounds, then $d_2 = 2.279$ inches.

The fire surfaces of a boiler have a thickness of ½ inch to ⅝ inch, and the plate cannot be reinforced with washers, so the strength of the square of plate supported by four stay bolts is considered. Its support is such that the square of plate can be considered as a beam fixed horizontally at both ends, and the load uniformly distributed over the whole upper surface. Call the pitch of the stay bolts p_3 and the thickness of

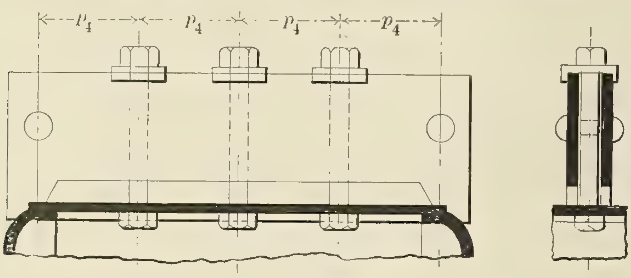


FIG. 13.

the plates t_3, then, from the formula for the safe loading of a beam fixed horizontally and uniformly loaded,

$$p_3 = 155\, t_3 \sqrt{1/P} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (40.)$$

where P is the boiler pressure.

Applying the above to a boiler with ½-inch sheets in the back connection, to carry 160 pounds working pressure, gives $p = 6.13$ inches.

Allowing these stay bolts a safe working load of 8,000 pounds per square inch of net section, as allowed by Lloyds for such stays, their diameter is

$$d = .0127\, p_3 \sqrt{P} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (41.)$$

Let $p_3 = 6.13$ inches, and $P = 160$ pounds, then $d_3 = 0.9845$ inch.

The top sheet of the combustion chamber must be supported by stays, but here it is not practicable to stay one sheet to another, so these stays are carried on girders, bridging the top of the fire-box from the back-tube sheet to the back sheet of the combustion chamber. The depth of the combustion chamber is generally such that three stays placed equally distant from the ends of the girders, and from each other, will give a proper pitch for them. The girder is in the condition of a beam supported at the ends and loaded with three loads symmetrically placed. It is made of a pair of plates separated by distance pieces slightly more than the diameter of the stays, and held together by rivets somewhat as in Fig. 13.

Let p_4 be the pitch of the stay bolts along the girder, and p_5 the pitch of the girders. The load on each stay is $P \times p_4 \times p_5$. Let h be the depth of the girder and b the thickness of one plate of the girder, then, from the equation for safe loading for such girder,

$$h = \sqrt{\frac{P\ (l^2_2 p_5 - l_2 p_4 p_5)}{12{,}000\ b}} \ldots\ldots\ldots\ldots\ldots\ldots (42.)$$

where l_2 is the distance in inches between suports.

Very often $l_2 = 4\, p_4$, then $h = .0316\, p_4 \sqrt{\dfrac{p_5 P}{b}} \ldots (43.)$

By making $b = 1/10\ p_5$, which gives a good proportion of thickness of plate to depth of girder, $h = 1\ p_4 \sqrt{P} \ldots (44.)$

Assume, for a boiler to carry 160 pounds, that l_2 equals 24 inches, $p_5 = 7$ inches, and $b = 1/10\ p_5 = 0.7$ inch, then from equation (44) $h = 7.59$ inches.

THE TWIN-SCREW SHIP LADY FRASER.

There was launched March 1, from the yard of the Fairfield Shipbuilding & Engineering Company, Ltd., the pilot cruiser *Lady Fraser*, which has been specially built for the service of the Indian government. She is a twin-screw vessel, length 301 feet 6 inches, breadth 38 feet, and depth 21 feet, with a speed of 12½ knots; schooner-rigged, having three pole masts specially high for signaling purposes, and fitted for wireless telegraphy. A special feature is the pilot's pinnace, which is placed on chocks between the main and mizzen masts, and a most efficient arrangement has been made for the rapid handling of this boat, which has to be unshipped at sea with the pilots on board, four steam winches being provided for this purpose.

Under the forward end of the bridge deck there is situated a large, well-lighted and handsomely decorated saloon for the use of the pilots as a reading and smoking room. This may be transformed into a dining saloon when desired. There is also an elegantly furnished suite of staterooms and bath room for the use of the government officials, and abaft these rooms is the accommodation for the ship's officers, each having a separate cabin. The captain's cabin, combined with the chart room, is arranged under the bridge. Commodious accommodation for the pilots, twenty-six in number, is arranged on the lower deck, forward, where two large dining tables, with revolving chairs, are fitted. The pilots are berthed in swinging cots, which are unshipped and stowed in racks when not in use. The leadsmen's quarters, fitted up to accommodate ten persons, is on the lower deck, immediately abaft the engine room, and aft of this again, and separated by a steel bulkhead, is the crew's quarters.

The native crew, including deck hands, firemen, servants, etc., numbering about fifty, as well as the leadsmen, sleep in hammocks, and their quarters are spacious and well ventilated.

The crew's washhouses, etc., are located on the upper deck, aft.

Cold chambers for preserving meat and vegetables are fitted on the platform deck under the crew's quarters, with access by means of a trunk from the bridge deck. These compartments are efficiently insulated with granulated cork, and cooled with brine led from the refrigerating machine, which is placed at the after end of the engine room. Brine is also led to the thermotanks on the upper deck, which supply cold air to the officers' and pilots' quarters, this being regulated by means of louvres in each compartment. Special attention has been given to the natural ventilation of the vessel, which is most efficient throughout; portable electric fans are fitted in the staterooms, pilots' quarters, smoking room and engineers' mess. There is also a complete installation of electric lights.

The propelling machinery consists of two triple-expansion surface-condensing engines, each having three inverted cylinders working on three cranks. The high-pressure and intermediate-pressure cylinders are each fitted with a piston valve, and each low-pressure cylinder with a single ported slide valve, all the valves being worked by the usual double eccentric and link-motion valve gear. The crankshaft is in

three pieces, each piece being built and interchangeable, and, together with the thrust, tunnel, and propeller shafts, is of forged mild steel. Each screw propeller has three blades of bronze.

The condensers are separate from the main engines, built of steel boiler plates and galvanized, the condensing water being supplied by two large centrifugal pumps, one for each condenser, each worked by an independent steam engine, and each capable of supplying circulating water to either condenser in the event of one pump being disabled. Both circulating pumps will be connected to large valves leading to the bilges, so that in case of need these pumps could be utilized in pumping out the engine room.

There are two boilers, of the multitubular marine type, to work with natural draft, constructed entirely of steel and adapted for a working pressure of 200 pounds per square inch.

BUILDING A HARBOR.

BY CHARLES F. HOLDER.

In following along the shore line of California, one is impressed with the fact that in the 600 or more miles of sea coast, from San Diego to San Francisco, there are but two good harbors. Both are at the extremes. San Diego Bay is a fine, natural harbor, as is also San Francisco Bay; but between these two the harbors are not worthy the name, and in the East would be termed open roadsteads. Monterey Bay affords some protection, but Hueneme, Fort Harford, Santa Monica, Redondo, Ventura and Newport are open roads, from which all vessels are obliged to flee in case of bad storms. Santa Barbara, due to the islands off shore, affords fair protection to shipping, but all these ports are not harbors, and the growing commerce of the past decade has been seriously hampered by the lack of a port where vessels could lie at all times; a port in the vicinity of Los Angeles—the center of commercial activity in Southern California.

This demand has found expression in various directions. An attempt was made to build a wharf at Redondo, a few miles from Los Angeles, and many vessels stop there, but they lie at the long wharf in the roll of the surf, and would be obliged to leave in a gale, which, it may be said, rarely comes. A similar port is seen at Santa Monica, where the Southern Pacific Railroad has built a fine wharf directly out to sea in an open roadstead; and piers have been constructed at Newport, Long Beach and at other points. For many years attempts have been made to secure a large government appropriation for a harbor at some point, but owing to local jealousies the end wished for has invariably been defeated. Various boards have been appointed by the government to report upon a suitable site, and with remarkable unanimity they have reported on San Pedro. But the Southern Pacific Railroad—a strong factor—took the field in favor of Santa Monica, and so the matter has been delayed until within a year or two, when a final board reported again in favor of San Pedro, and the work began—perhaps the largest contract of the kind ever given in America; certainly the largest on the Pacific Coast.

The location selected has this advantage: that it already has a good harbor, affording protection and wharfing to full-rigged ships and to the largest Pacific coastwise steamers. The entrance and the inner harbor is shown in Fig. 1. The location was originally a lagoon, formed by Dead Man's Island; but by breakwaters it has been changed into a small but good harbor of refuge, the narrow entrance leading to an inner bay of large extent, which can readily be dredged and made a good harbor for a large fleet. But the plan at present is to form an outer harbor, and to this end the government advertised for bids for work on a breakwater of stone, which should be built across the field of the prevailing wind. The breakwater was to be 8,500 feet in length, which it was estimated would provide an area of quiet water equal to 1 square mile. The nature of the work can be imagined when it is understood that the water in which the wall of rock was to be built ranged in depth from 25 to 52 feet. To build up the wall would require 2,290,000 tons of rock. The government demanded that a floor, or base, should first be made by the deposition of small stones on the ocean bottom, regularly arranged, which was to be the platform upon which the wall was to rest. Upon this, for a distance of 12 feet upward from the bottom, there should be a mass of stone which should weigh 130 pounds to the cubic foot; none of the pieces to weigh less than 100 pounds; one-third to weigh not less than 1,000 pounds, and one-third of the pieces not less than 4,000 pounds in weight. At this stage, or when a height of 12 feet is completed, the base must be 90 feet in width, and from this point on the wall to gradually lessen in width, being formed entirely of rocks ranging from 6,000 to 16,000 pounds in weight, the largest being piled upon the outside, where it is assumed the sea will break with the greatest force.

FIG. 1.—THE ENTRANCE AND INNER HARBOR AT SAN PEDRO.

The work of construction is now being vigorously carried on by the contractors. San Pedro is a small town, reaching out in the direction of a prominent headland known as Point Firman. At a point about 2 miles from the town and opposite the location of the breakwater, the construction company have begun operations by building an elaborate bridge of piling, Fig. 2, which reaches out from shore like a huge snake. This is to enable the cars loaded with rock to reach the head of the breakwater. The rock comes from several quarries—Chatsworth and Declez being the most important, the latter 60 or 70 miles distant. The Chatsworth stone, judging from samples taken by the writer from the car while it was being weighed, is a very soft and friable sandstone, easily crumbled in the fingers; yet experts have pronounced it amply sufficient for the purpose. The inspector stated that only about one-fifth of the work was to be made of this stone. The rock from the Declez quarry, at Colton, is a granite abounding in mica, undoubtedly well adapted for the purpose. The cars are loaded at the quarry with huge blocks and shipped without delay to San Pedro; when within an eighth of a mile from the pier each car is rolled upon a scale and weighed, then when the entire trainload has been weighed the cars are sent down the line out upon the long pier. Here is stationed a powerful engine, with a crane, which lifts the stones, Fig. 3, from the cars and turns them over the water, where they hang suspended a moment until the engineer jerks a release string, shown in Fig. 3, and the huge rocks fall with a crash and disappear, while a mass of foam and water rises high in air—a striking spectacle from the distant shore.

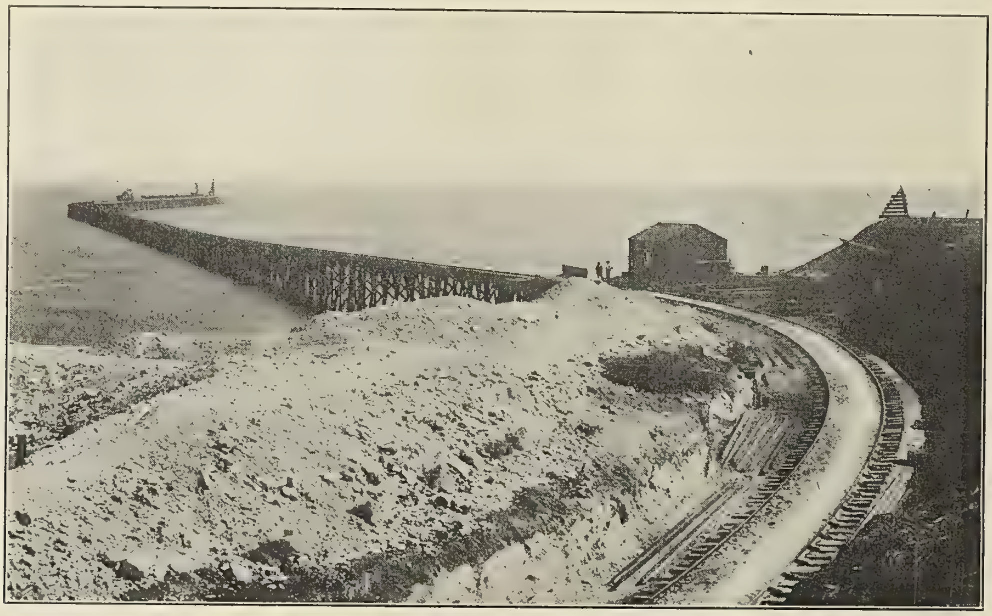


FIG. 2.—CONSTRUCTION PIER USED IN BUILDING THE BREAKWATER.

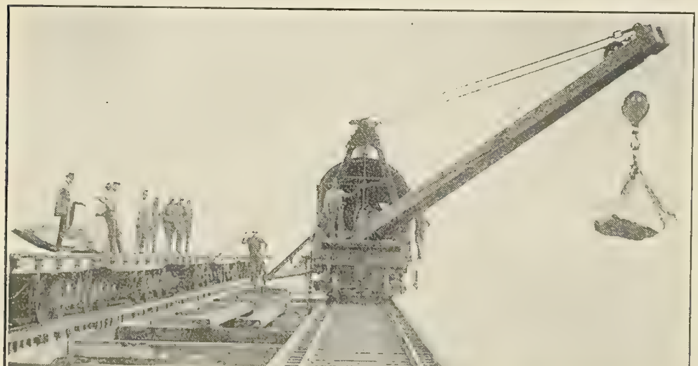


FIG. 3.—HANDLING THE STONE ON THE CONSTRUCTION PIER.

The work is progressing rapidly, and for some distance the breakwater is at the surface, so that the sea breaks upon it. A sea captain, who leaves the port of San Pedro daily, informed the writer that already the effects of the wall are appreciable, and that the heavy swell which formerly was met at the entrance of the outer harbor is no longer felt in so marked a degree, and in his estimation in a year and a half the sea wall, while not completed, will be fully up to all that is required of it. It was estimated that five years will be required to complete the work, at which time the breakwater will rise 14 feet above water at low tide and about 7 at high tide. The contract price was $2,375,000, and it is estimated that 92,000 carloads of stone will be required. The upper portion, or superstructure, will be more or less ornamental, and the entire work promises to be attractive as well as useful, and justified by the commercial growth of the wealthiest county in Southern California. It is interesting in this connection to glance at Dana's "Two Years Before the Mast," and read his description of this precise locality, where but a few decades ago he lay in a ship to receive the the hides which were tossed over the cliff, the vessel lying off shore ready to run before the winter southeasters. At present all this is changed. The inner harbor is filled with ships and steamers, and in a short time the great breakwater will provide a harbor of refuge suitable for the largest navy in the heaviest gale.

Argentine Battleships.

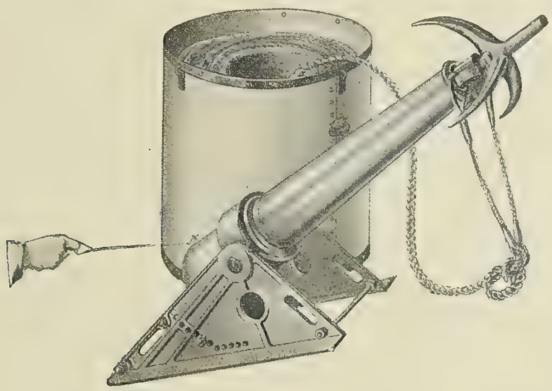
Specifications for the new battleships authorized to be constructed for the Argentine Republic are generally reported as follows:

Displacement, 19,000 tons; speed, 21 knots; armor, 12, 10.8 and 6 inches. The armament is to consist of ten 12-inch guns, mounted in five turrets; fourteen 6-inch rifles and eighteen 3 and 2¼-inch rapid-firing guns. The propelling machinery is to consist of turbine engines, and hydraulic gear is to be adopted for operating the turrets. There will be two sister ships, the *Moreno* and *Rivadavia*, which, added to the four of the *Belgrano* type already owned by the Republic, are considered to represent a full equivalent to the three Brazilian *Dreadnoughts, Minas Geraes, Sao Paulo* and *Rio de Janeiro.*

corner of the shank will be moving in a straight line in contact with the opposite side of the guide. The corresponding corner of the head of the tool would at the same time strike out a straight line in the work. This motion takes place on all four sides of the guide, except for a little space at each corner, the result being that the hole is perfectly square except for a slight rounding at the corners. If it is desired to bore out a complete square with sharp corners, a special tool is employed, having a shank considerably larger than the head of the tool, one corner of the shank being rounded instead of angular. The exact form of this round-cornered shank has been worked out empirically and a complete set of templates made for the different sizes of tools apt to be required in actual practice. The tools for both the round-cornered and sharp-cornered squares can be ground by means of a special attachment to the ordinary grinding machine.

The Meyers-Rogers Self-Anchoring Life-Saving Projectile

For a good many years life-saving guns have consisted of small and unreliable cannon firing a small weight which carried a quarter-inch cord ashore. For the device to be of much value, it was, of course, necessary for someone to be on shore to make the line fast, and draw in a rope operating a breeches buoy. A new life-saving gun has recently been placed on the market by the Myers-Rogers Projectile Company, 17 Battery place, New York, in which the projectile anchors itself on shore without assistance, thus rendering the vessel independent of aid from land. This projectile is fitted with grapnels, which attach themselves firmly in earth or rocks, and carries a 2-inch manila rope, the whole outfit weighing only a few pounds more than the old-style apparatus. Since the rope is heavy enough to support a number of men, a breeches buoy can be quickly operated over it. The end of



the rope left on board the ship is tied to the highest point on the vessel, and a block reeved into it to which is attached the buoy. In operation the first man to be sent from the ship to the shore is a sailor, who takes with him, attached to the block of the breeches buoy a line, and, as he reaches the shore, he hauls in enough of this whip line to reach from the shore to the vessel, thus establishing an endless whip line by means of which the breeches buoy can be operated back and forth to convey passengers from the wrecked vessel to the shore. The breaking of the rope in firing the projectile is prevented by a heavy spring, a sliding ring and cable. It has been found that after having been fired fifteen times the rope does not show any wear. The cannon used is made out of forged steel, 2 inches thick at the breech, and has a margin of safety of 125,000 pounds. It can be handled by two men and transported to any portion of the vessel.

COMMUNICATION.

Jet Propulsion.

Editor International Marine Engineering:

The interesting problem of propelling vessels by means of a jet occupies a prominent place among many others unsolved, not because of the seeming impossibility or limited field of application, but simply for the reason that very little has been done in the way of experimenting, and even that very roughly and incompletely. Anyone will tell you that jet propulsion has no future and that complete failure was invariably the result of all experiments. Very few, however, will be able to state where and how these experiments were made and just how brilliant was the victory of the screw over its modest and silent opponent. Theories and formulæ have been advanced from time to time by eminent engineers, but by the way of illustration we give the following table of comparative tests made by the late Dr. Zeuner, with his usual thoroughness, the same boat being used in both tests:

	Screw. Sept. 5, 1891.		Jet. June 21, 1892.	
	Miles Per Hour.	H. P.	Miles Per Hour.	H. P.
Down stream...	10.77	25.31	11.24	22.25
Up stream......	6.17	23.45	6.4	22.25

This table seems to show that, after all, the jet has a little advantage over the screw in both speed and power consumption. And yet this was the first and only test made in a more or less thorough manner. Dr. Zeuner's theory is not the only one that can be advanced on the subject. In fact, it has recently been pointed out that this theory actually contains a mistake, but at any rate his or any other theory is bound to be considerably simpler and easier than, for instance, that of the screw. Of course the difficulties of a theory should not necessarily constitute a disadvantage if only the theory itself is plausible and if the results obtained are in full accordance with those expected. But is really such the case? If the trial speed does not come up to that required by the contract, is it not customary to replace the propeller, altering the pitch one way or the other, regardless of all theories? And even so, does the efficiency of the screw really present something so exclusive as to prohibit any attempt of exceeding it? The screw propeller necessitates a heavy, slow-speed engine, heavy shafting is expensive and presents all sorts of interesting possibilities—racing, breaking off, etc. It is a well-known fact that sometimes three propellers give a better result than four, and perhaps two would give a still more encouraging performance.

Again, let it be remembered that only low-grade centrifugal pumps were used for jet propulsion, sometimes reversed parallel turbines, very clumsy and inefficient; with modern high-duty turbine pumps much better results would be possible. The efficiency of the old-time centrifugal pump must have been much less than 50 percent, since one of the German writers naively states that a pump of 50 percent efficiency or over is bound to solve the issue. The velocities required are not very great, and the total lift to be produced by the pump is exceedingly low, contrary to the prevalent layman's opinion. So that a turbine pump can easily be made to give an efficiency of 75 percent or more for these conditions. The pump can be driven by a small, high-speed steam (or producer gas) engine, and the extra piping required would probably weigh not more, and would certainly cost less, than the propeller. The impossibility of racing and the probable absence of vibrations make the jet propeller still more attractive. A fair investigation on a large scale is imperative, and a friendly exchange of experts' views in the columns of International Marine Engineering would be desirable.

Philadelphia. N. W. Akimoff.

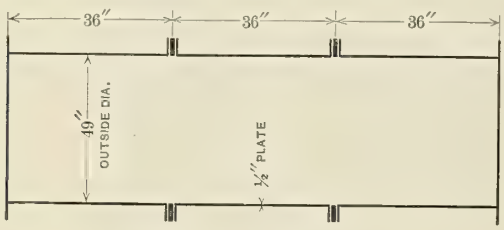
QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q.—What is the correct formula for determining the safe working pressure on an Adamson furnace? What is Lloyd's formula for this?
C. B. S.

A.—The rule specified by the United States Steamboat Boiler Inspection Service is as follows:

$$P = \frac{C \times T^2}{L \times D}$$, where P = working pressure in pounds per square inch; C = 89,600, where the distance between rings is not more than 8 feet; T = thickness of plate in inches,



SECTION OF ADAMSON FURNACE.

which must not be less than 5/16 inch; L = distance between rings in feet, and D = outside diameter in inches. For the furnace shown in the sketch this formula figures out

$$P = \frac{89{,}600 \times (\frac{1}{2})^2}{3 \times 49}.$$

P = 152.4 pounds.

Lloyd's rule, where the length of a flat portion of the furnace, that is, the distance between flanges, is greater than 120 times the thickness of the plate, is

$$P = \frac{1{,}075{,}200 \times T^2}{L \times D}$$, but where the length of the straight portion is less than 120 times the thickness of the plate;

$$P = 50 \times \frac{(300\,T - L)}{D}$$, where D = outside diameter in inches; T = thickness of plate in inches; L = length of plain cylindrical part in inches, measured from the commencement of the curvature of the flanges of the furnace where the rings are fitted. For the furnace in the sketch, $120 \times T = 60$ inches. This is greater than the length of one section of the furnace; and, therefore, the second formula should be used. Since the length of one section of the furnace is 36 inches, the length of the straight portion of the furnace between the flanges would be about 33 inches. The formula would work out as follows:

$$P = 50 \times \frac{(300 \times .5 - 33)}{49}.$$

P = 119.4 pounds.

MR. JAMES DONALD, who has been naval architect for the New York Shipbuilding Company, Camden, N. J., for the past eight years, or since the formation of the company, is now established at 17 Victoria street, London, S. W., as a consulting naval architect. Mr. Donald was formerly connected with the Fairfield Shipbuilding & Engine Company, Glasgow, as assistant to Dr. Elgar in their London office, and with the Union Iron Works, San Francisco, Cal., as naval architect.

TECHNICAL PUBLICATIONS.

Steam Boilers. By Prof. C. H. Peabody and Edward F. Miller. Size, 5¾ by 9 inches. Pages, 420. Figures, 175. New York, 1908: John Wiley & Sons. Price, $4.

The former edition of this book, published in 1897, has become so well known as a standard textbook on the subject of steam boilers that little need be said regarding that part of the book, which is a repetition of the former edition. In the new edition a considerable amount of new material and many new illustrations have been added. While the number of subjects treated, and the order in which they are taken up have not been greatly changed, yet each chapter has been added to and revised to bring the work up to date. A chapter has been added on superheaters, in which the various types of superheaters now in use are illustrated and described. The best materials for use as steam-pipe fittings for superheated steam are considered. Considerable additional matter is given on the subject of steam piping, including the strength and expansion of pipe, the bursting point of extra heavy flanged fittings, the area of steam pipes, the flow of steam in pipes, and, finally, pipe coverings. A number of valuable tables, giving the dimensions and floor space occupied by different types of boilers and of economizers, have been added to the appendix. Other valuable features of the book include a comprehensive treatment of the subjects of fuel and combustion, corrosion and incrustation, a detailed description of the method of testing boilers, including gas analysis, measurement of air used, temperatures, etc. The principles and methods explained in the early chapters of the book are finally brought together and illustrated by applying them to the complete design of a horizontal tubular boiler.

Pumps (*Power* Hand-Book Series). By Hubert E. Collins. Size, 4½ by 6¾ inches. Pages, 99. Figures, 35. New York, 1908: Hill Publishing Company. Price, $1.

One of the most important auxiliaries in any power plant, whether on board ship or on land, is the boiler feed pump. Every engineer must be thoroughly familiar with this small engine, and must be able to hunt out troubles and remedy them with dispatch. Many instances related in this book will be found of value to engineers who have trouble with their pumps. About half of the book is taken up solely with the subject of pump troubles. Valuable information is given on the subject of setting the valves of a duplex pump; finding the horse-power of a pump, and setting up and operating pumps. At the end of the volume a number of pages of useful tables are given, including heights in feet to which pumps will lift water; friction loss in pounds pressure per square inch; horizontal and vertical distances reached by jets; pressure of water, areas of circles, etc.

The Star Improved Steam Engine Indicator. By George H. Barrus. Size, 4½ by 7¼ inches. Pages, 140. Figures, 23. Boston, 1908: The Star Brass Manufacturing Company.

Although this treatise was prepared especially to describe one particular make of indicator, it cannot be considered as solely an advertisement for the new indicator; for it is an impartial statement of the entire subject of indicator work, including chapters on descriptions of the details of the Star improved indicator, and afterwards a careful consideration of indicator diagrams, the mehods of working up the diagram, the use of the planimeter, and the computation of horsepower and steam accounted for by indicator diagrams. A part of the book is also devoted to the discussion of the subject of cylinder condensation and leakage, and the methods of combining indicator diagrams taken from multiple expansion engines. Numerous sample cards are shown, and the necessary tables for use in the computations involved are given.

The Girl and the Motor. By Hilda Ward. Size, 4½ by 6¾ inches. Pages, 120. Illustrations, 5. Cincinnati, 1908: The Gas Engine Publishing Company. Price, $1.00.

This story is the result of the experiments of the author, a mere girl, who buys a small motor boat and later a 20-horsepower automobile. Without any previous experience with gasoline engines, she naturally meets with situations that call forth all the inventive temperament available. The remedies that occur—for instance, the employment of "buttonholes for bolts to go through"—are often unique. While this is not primarily a book of information on gas-engine troubles, yet neither has it the plot of a novel. It simply describes a series of interesting experiences in an entertaining way.

Shaft Governors (*Power* Hand-Book Series). By Hubert E. Collins. Size, 4 1/3 by 6¾ inches. Pages, 127. Figures, 35. New York, 1908: Hill Publishing Company. Price, $1.

Technical books covering exhaustively the subject of shaft governors are rare. The fact that this book is intended to cover this subject completely from a practical standpoint should make it of value to operating engineers. An interesting history of the evolution of the shaft governor is given, describing the various types, both centrifugal and inertia, which are now in general use. Definitions and rules covering the necessary terms form the subject matter of the second chapter, while succeeding chapters take up the subject of the adjustment of various types of governors, leading up finally to a consideration of steam turbine governors. The text is well illustrated and clearly written, so that the entire subject, which is usually considered somewhat complicated, is set forth in a comprehensible manner.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

898,551. BOAT PROPELLER. LORENZO C. BUTLER, ARION, IA.

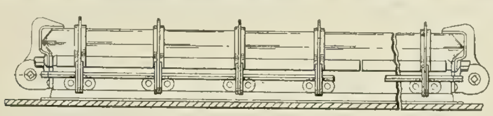
Claim 1.—In combination with a boat having a rod supported by the opposite walls thereof, oscillating levers mounted upon said rod, a rudder, an angled lever connected to the rudder shaft, rods connecting the arms of said angled lever with said oscillating levers, longitudinal movable rods pivotally connected to the lower ends of the oscillating levers, the forward ends of said rods being bent to form foot rests. Four claims.

902,996. SHIP-PROPULSION SYSTEM. CHARLES ALGERNON PARSONS, OF NEWCASTLE-UPON-TYNE, ENGLAND.

Claim 1.—A ship-propulsion system comprising in combination a propeller shaft, reciprocating engine means connected to said propeller shaft, a separate shaft, turbine means on said separate shaft and receiving working fluid from said reciprocating engine means, together with means for transmitting power from said separate turbine shaft to said propeller shaft. Fourteen claims.

904,275. HATCH-FASTENING DEVICE. ORTEN PETERSON PECKHAM, OF RIVER ROUGE, MICH.

Claim 1.—In a hatch-fastening device the combination with a plurality of movable clamping hooks adapted to engage the hatch cover,



means for simultaneously actuating said hooks to carry them into engagement with the cover, and means for simultaneously locking said hooks against outward or backward movement. Nine claims.

904,135. SPEED-INDICATOR OR LOG FOR SHIPS. HEINRICH G. A. KLAPPROTH, OF HANOVER, GERMANY.

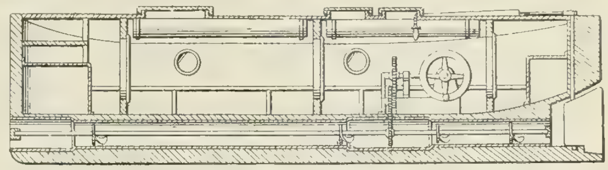
Claim 2.—In a speed-testing mechanism for ships, the combination, with the hull of a ship, of a bracket, a cylinder secured in said bracket, a fluid, in said cylinder, a piston rod and head slidably arranged in said cylinder, a speed-indicating mechanism, a concave disk rigidly secured to the free end of said piston rod adapted to offer a resistance to the water through which the ship passes so as to exert a pressure upon said fluid and by means of said fluid distributing said pressure to said speed-indicating mechanism. Five claims.

904,285. MARINE PROPULSION. WILLIAM P. THOMPSON, OF LIVERPOOL, ENGLAND.

Claim 2.—A vessel and a series of long, narrow supporting fins or hydroplanes having their inner ends connected to the body of the vessel on each side of the center line and extending beyond the gunwale, said fins being disposed at short intervals for nearly the entire length of the vessel, whereby every part of the vessel is supported. Thirty-two claims.

904,372. LIFE-BOAT. JOHN H. STOELT, OF SEBEWAING, MICH.

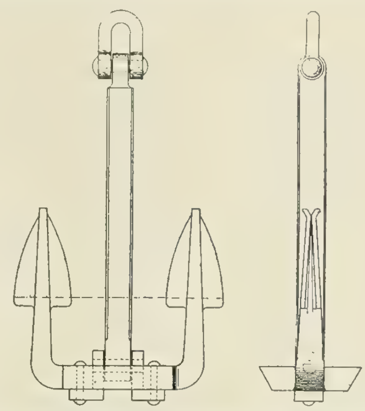
Claim 1.—In a life-boat a cylindrical body, an elongated keel member having a longitudinal tubular passage provided at intervals with ex-



panded portions, a propulsion member fitted in the passage and including a spur wheel arranged in one of the expanded portions of the passage, and cross bars constituting bearings for the propeller shaft disposed adjacent to the expanded portions. Five claims.

906,023. PALM FOR STOCKLESS ANCHORS. FRIEDRICH HEUSS, OF MANNHEIM, GERMANY.

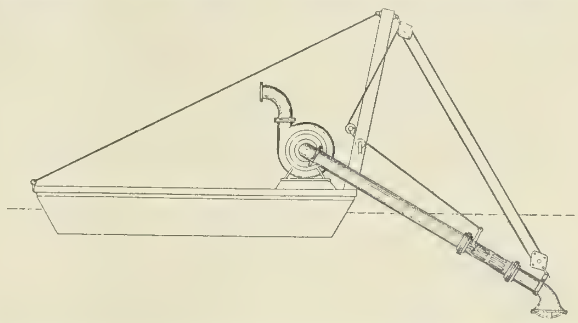
Claim.—A palm for stockless anchors, comprising two curved inclined ribs projecting inwardly toward the shank of the anchor, and two



curved inclined ribs projecting outwardly from said shank, the ends of said ribs forming a divided point of application. One claim.

906,234. SUCTION DREDGE OR THE LIKE. FRANKLIN H. JACKSON, OF BERKELEY, CAL., ASSIGNOR TO BYRON JACKSON IRON WORKS, OF WEST BERKELEY, CAL., A CORPORATION OF CALIFORNIA.

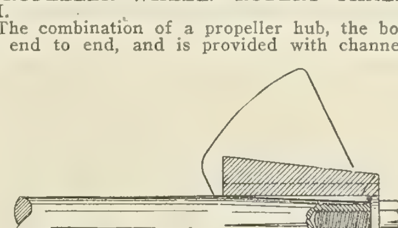
Claim 1.—The combination with a dredge, and the tubular suction pipe thereof, of a valve guided and turnable upon the exterior of the



pipe, said valve having alternate ports and closed spaces, corresponding ports in the suction tube, and means by which the valve ports may be registered with those of the pipe. Five claims.

906,337. PROPELLER WHEEL. ROBERT THALER, OF BAY CITY, MICH.

Claim 2.—The combination of a propeller hub, the bore of which is tapered from end to end, and is provided with channels whose ends



merge into the larger end of the bore, a shaft tapered at one end, keys on the tapered end, the keys at one end merging into the shaft, and means for securing the shaft and hub against relative longitudinal movement. Eight claims.

906,846. BATTLESHIP PROTECTION BY MEANS OF CONCRETE. LORENZO D'ADDA, OF TURIN, ITALY.

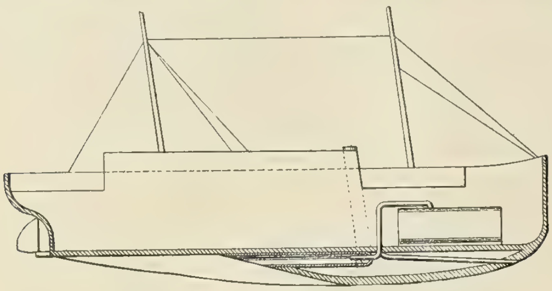
Claim.—An armor, comprising an outer metal wall, an inner metal wall, a plurality of intermediate partitions, concrete layers between the said partitions and the partitions and the said walls, of a hardness progressively increasing from said interior metal wall to the said outer metal wall. One claim.

906,716. MEANS FOR RAISING SUNKEN VESSELS. NICOLA JELPO, OF NAPLES, ITALY.

Claim 1.—An apparatus for raising sunken vessels, comprising a cylindrical inflatable bag, a wire netting inclosing said bag, the bottom of said netting being formed into a loop, an iron bar placed on each side of said loop, means for clamping said bars together, ropes attached to said clamping means, and means for inflating said bag after the same is sunk. Two claims.

907,086. PROPELLING MEANS FOR VESSELS. WALFRID TH. NASELIUS, OF KENNEDY, MINN.

Claim 1.—The combination of a hull having a central keel extending longitudinally from the bow to midship and terminating at its rear in an upwardly-inclined surface, an injector discharging rearwardly and

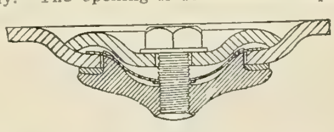


terminating in the said inclined surface, side keels disposed parallel to each other with their front ends disposed at opposite sides of the central keel and in overlapping relation to the rear end of the latter, an air pipe disposed within the hull with its lower end connected with the injector and its upper end open to the atmosphere, and means for supplying fluid under pressure to the injector. Two claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

13,800. MAN-HOLE DOORS. W. A. SMITH, DERBY.

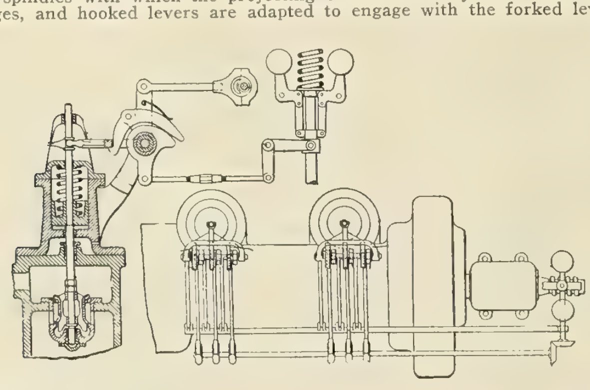
The invention is intended chiefly for use with range boilers, but is applicable generally. The opening is formed in a depressed part of the



shell of the boiler, and is closed by inner and outer covers. A cross-bar threaded on the securing-bolt holds the inner cover on its seat while the outer cover is being secured.

13,583. TURBINES. F. HODGKINSON.

A normal and overload puff-governing mechanism for elastic-fluid turbines is shown. The governor controls a normal-load valve in the primary inlet and an overload valve in the secondary inlet, the valves being operated by similar gearing set progressively. Each valve has collars on its spindles with which the projecting end of a widely-forked lever engages, and hooked levers are adapted to engage with the forked lever.



The hooked levers are carried by rocking levers reciprocated by eccentrics, and are controlled by progressively-set cams connected to a rocking shaft adjusted by the governor. The arrangement is such that the hooked levers in their oscillations successively engage with the forked lever of the normal-load valve as the load increases, and increase the valve opening until that valve is working at its full capacity; the overload valve is then similarly operated, and vice versa.

13,975. SCREW PROPELLERS. W. MITCHELL, T. B. KEEDY, SOUTH SHIELDS.

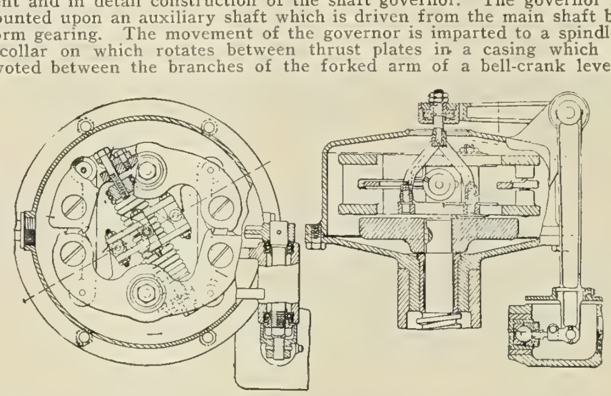
In order to increase the propulsive effect of screw propellers, the root portion of each blade is set in a plane more nearly at right angles to the axis of the boss than the plane of the outer or more effective portion. The overhanging portions are strengthened by supports.

13,921. TURBINES. W. CLARK, GLASGOW.

A hollow cylindrical or conoidal drum carries a series of outward-flow blades which co-operate with standing blades fixed to the casing. The motive fluid flows in a serpentine manner along the turbine. A multiple leakage-preventing device is arranged at the high-pressure end of the drum, and the fluid which leaks past this device is utilized in the lower-pressure stages. Ring packings prevent the leakage of steam at the spaces between the fixed and running blades.

14,684. TURBINES. WARWICK MACHINERY CO., LONDON.

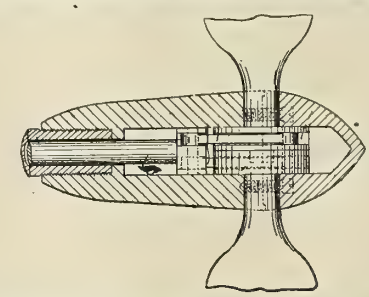
Relates to the governing mechanism for the admission valves of certain elastic-fluid turbines, and consists in modifications in the general arrangement and in detail construction of the shaft governor. The governor is mounted upon an auxiliary shaft which is driven from the main shaft by worm gearing. The movement of the governor is imparted to a spindle, a collar on which rotates between thrust plates in a casing which is pivoted between the branches of the forked arm of a bell-crank lever.



The other arm of the lever carries a pin having a spherical end socketed in a bearing in the end of the eccentric shaft, which actuates the valve-operating dogs, to transmit to it axial movement according to the movement of the governor for the purpose of engaging or disengaging the valve-rods and the dogs. The governor comprises two masses pivoted and held in opposition to the centrifugal force by a single spring. The masses are provided with lugs so that the oppositely moving ends interlock at a maximum speed. The angular movement of the masses is transmitted to the spindle by links.

15,353. SCREW PROPELLERS. T. THOMPSON AND VILLINGER'S PATENT REVERSIBLE PROPELLER SYNDICATE, LONDON.

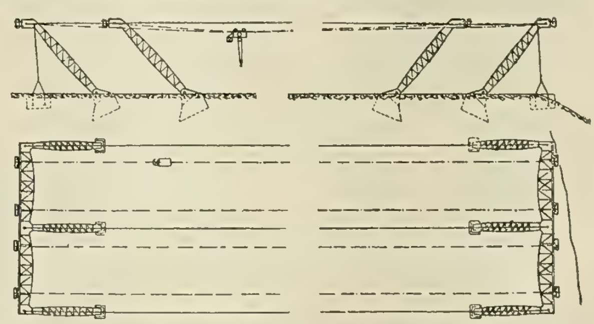
In reversible propellers in which the blades are operated or reversed while in motion by a central rod sliding in the hollow driving shaft, the rod is operated by a screw-and-nut mechanism designed to move the rod smoothly and evenly and to retain it in any position. The central rod is connected to a brush which is loosely mounted on the hollow driving



shaft and is provided with a projecting collar. This collar engages with the ends of a threaded sleeve moved longitudinally by a nut caused to rotate in a fixed bearing. An extension of the sleeve is flattened on both its side faces, which engage between forks of the main bearing bracket so as to prevent rotation of the sleeve. To facilitate the operation of the blades and to prevent cross winding, the inner ends are enlarged at their adjacent faces bearing against each other, and one being provided with an axial pin fitting in an axial recess in the other. Slots are cut for the operating rods.

16,526. SHIPBUILDING SLIPS. DUISBURGER MASCHINENBAU-AKT.-GES. VORM. BECHEM & KEETMAN.

Relates to cable traveler installations for slipways, and consists in the arrangement of adjacent slipways with a view to economize space. The



adjacent supports are arranged in a straight line, but relatively staggered; or a common support is employed. The former is particularly useful when the slipway makes an acute angle with the water's edge.

16,991. GAS TURBINES. S. KOWACZEK, BAHNHOF, ZABRZE, GERMANY.

In apparatus of the type in which the driving-fluid acts on pockets in the circumference of a rotary disk the explosive mixture is driven into the explosion chamber by pumps driven directly from the main shaft. The disk is partly surrounded by a casing provided with an explosion chamber whence a tangential passage leads to the circumference of the disk. Explosive mixture is supplied to the chamber through a pipe fitted with a non-return valve, by pumps driven by eccentrics on the main shaft, and a vaporizer. The ignition mechanism is actuated by tappets on the disk. A spring-controlled valve is placed between the chamber and the passage to the disk.

International Marine Engineering

MARCH, 1909.

THE HAMBURG-AMERICAN LINE STEAMER CLEVELAND.

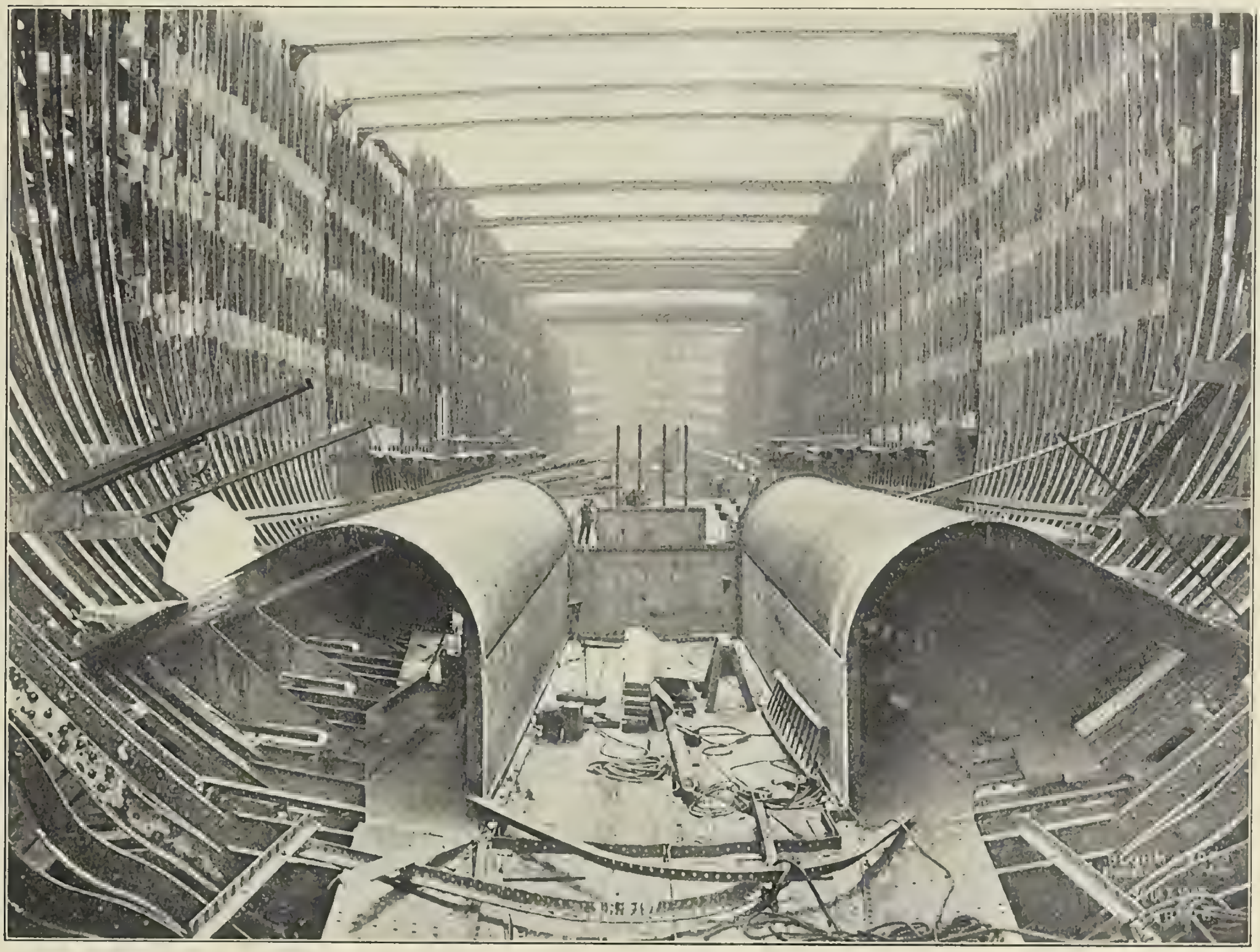
Two new twin-screw steamships are now being built in Germany for the Hamburg-American Line. One of these, the *Cleveland,* was launched from the yards of Blohm & Voss, in Hamburg, on Aug. 14, 1907, and it is expected that she will make her maiden trip to New York this month. The *Cleveland* is built of steel, to the highest class of the Germanischer Lloyd rules, and also in accordance with the regulations of the Board of Trade and the German and American laws for carrying emigrants. The principal dimensions are:

Length between perpendiculars	587 feet 6 inches.
Length over all	608 feet 8 inches.
Breadth on frames	65 feet.
Depth molded	50 feet.
Loaded draft	32 feet 8½ inches.
Tonnage, gross register (about)	17,000
Tonnage, net register (about)	10,000
Deadweight capacity, tons (about)	13,000
Displacement on 32 feet 8 inches draft	27,000 tons.

Cargo capacity, including fourth class passenger compartments, about 470,578 cubic feet.

Cargo, cold-storage room, about 35,000 cubic feet.

The ship is rigged with four schooner masts, having six Mannesman tube derricks on every mast, including one capable of carrying 25 tons. The derricks are worked by twenty steam winches of the latest pattern, serving eight hatches in all. A strong windlass and two steam capstans on the forecastle and two steam capstans near the stern, besides two boat or coal-hoisting winches, from the remainder of the auxiliary machinery on deck in addition to the steam steering gear.

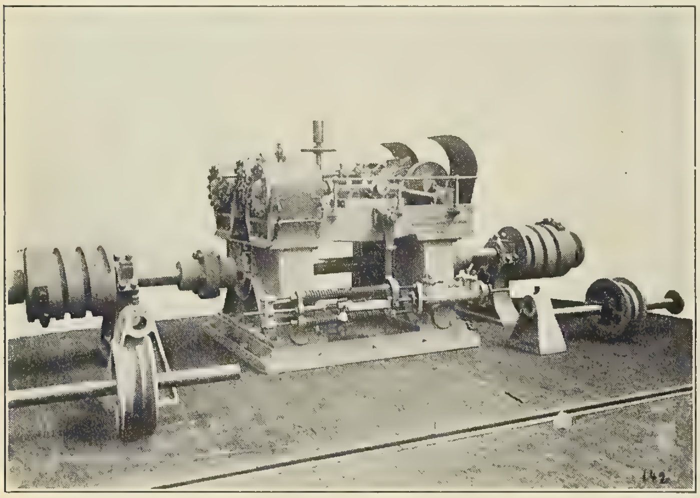


FRAMING OF THE CLEVELAND.

The main superstructure amidships extends to 100 feet forward and 154 feet aft the center of the ship, and is gradually tapered away to the uppermost deck. One expansion joint has been provided to prevent heavy stresses on the thinner plating. There are seven decks amidships: The lower, 'tween, saloon, upper, bridge, promenade and boat deck, while fore and aft of the propelling space one extra deck, the orlop, is fitted,

Since the *Cleveland* is built as a hurricane-deck ship, she has no forecastle or poop. There are two deck houses on the forward portion of the weather deck between the large cargo hatches, containing the emigrant galleys and sculleries. The tops of the galley houses are of especially strong design, to support the steam winches for loading purposes. On the after end of the ship two steel houses have been erected, one for another steam galley and one for the second class smoking room and ladies' saloon.

The upper part of the shell plating has been strongly constructed and hydraulic-riveted with snap-head rivets on the outside. The shell below the low-waterline in the fore part of the vessel is 1 inch thick, and has been well stiffened to resist ice. The keel consists of a 52½ by 1-inch plate, with a flat-bar keel, 14 by 3½ inches, fitted below as a rubbing piece. A cellular double bottom, 54½ inches high, with floors on every frame, is fitted throughout the vessel, extending to 80 percent of the ship's breadth. The frame spacing is 30 inches, reduced to Lloyd's requirements for ice-resisting construction



THE STEERING ENGINE.

in the fore part of the vessel. The framing consists of 8⅝-inch channel bars, with web frames fitted two frames apart in the machinery space and every fourth frame in the cargo holds. The deck beams are also of channel section, and are connected to the frames by bracket knees. Three rows of solid pillars are fitted throughout the ship. The engines are placed on top of the cellular bottom, which has been raised for the purpose.

Exposed decks are sheathed with Oregon pine throughout, whereas pitch pine has been used in all covered places and saloons. For the crew spaces and hospitals Litosilo has been adopted; the galleys, pantries, sculleries and refrigerating spaces are sheathed with tiles. India rubber tiles have been laid in smoking rooms, staircases and other passages adjoining first-class passenger accommodations. Bitumastic covering has been used for bunkers, cellular double bottoms and other parts of the steel structure subject to wide variation in temperature, in order to prevent corrosion.

The stern frame and brackets for supporting the tail shafts are cast steel. The rudder is designed in two pieces, in order to unship the lower part while the ship is afloat, having a shaft of Siemens-Martin steel and shrunk-on brackets riveted to a 1-inch single plate. The stem bar is of forged Siemens-Martin steel, formed to take the shell plating, and connected by means of a steel casting to the keel of the ship.

The sub-division by watertight bulkheads and decks is worked out according to the regulations of the Germanischer Lloyd and the See-Berufsgenossenschaft; a system which enables the loaded ship to maintain a satisfactory reserve buoyancy even when two adjoining compartments are filled with water up to the upper deck. To provide for accidents, the watertight bulkhead doors in the main holds have been fitted with the Lloyd-Stone system of closing, whereby all can be closed in a few seconds from the captain's bridge. A powerful hydraulic plant has been fitted to work the doors, and an automatic indicator is placed on the bridge, in order to show the position of each door.

PROPELLING MACHINERY.

The vessel is fitted with two main engines of the four-cylinder, vertical, inverted, direct-acting quadruple expansion type, balanced according to Schlick's system, and each capable of developing about 4,650 indicated horsepower at 80 revolutions per minute. The sequence of the cylinders, beginning forward, is high pressure, low pressure, second and first intermediate pressures, and the diameters of the cylinders are 29½, 42 29/32, 61⅜ and 86½ inches, with a common stroke of 55⅛ inches. The diameter of the crank shaft is 17 inches, the whole length of the shafting being 242 feet. The high-pressure and first intermediate-pressure cylinders have piston valves, the others double-ported slide valves. The diameter of all valve spindles is 4½ inches, that of the piston rods 8 inches. The valves are operated by Stephenson's link motion from eccentrics, and the reversing can be done by steam or hand.

Each of the engines has a main condenser, the cooling surface of which is 7,200 square feet, and each condenser has a separate centrifugal circulating pump of Gwinne's make, the diameter of the impeller being 48 inches. Each condenser has a separate air pump of Blake's design, 12 by 28 inches by 18 inches stroke. The air pump discharges into a tank, from which the water is brought by a Weir pump into a Weir feed-water heater, and from thence by another Weir pump into the boiler. There are three Weir pumps, 20 by 14 by 27 inches, one of them standing by while the other two are working.

There are two propellers of the three-bladed built-up type, which turn outboard when going ahead. The diameter is 19 feet 4 inches; pitch, 21 feet 8 inches; projected area of each propeller, 74 square feet, and developed area 88 square feet.

BOILERS.

Three single-ended and three double-ended boilers, with 214 pounds per square inch working pressure, are placed in one boiler room, the products of combustion passing off through two funnels. One single boiler is situated at the after, the other two single-ended boilers at the fore part of the boiler room, and the three double-ended boilers are placed between them athwartship. The total heating surface of all the boilers is 23,000 square feet, and the grate area 525 square feet. The furnaces are of the Morison corrugated type, having a maximum diameter of 49 inches and an internal diameter of 45 inches, the length of the fire bars being 67 inches. Each double-ended boiler has six and each single-ended boiler three furnaces. The outside diameter of both the ordinary and the stay-tubes is 2¾ inches, and the length between tube plates 94½ inches.

The mean diameter of all boilers is 16 feet 7 inches, the whole length of the double-ended boilers outside the front plates 20 feet 8 inches, and that of the single boilers 11 feet 10 inches. The boilers are fitted with Howden's system of forced draft, the air being supplied by two fans placed in the engine room. The fan wheel is 8 feet 6 inches diameter, and is directly coupled with a single-cylinder steam engine of 8-inch diameter and 7-inch stroke. Each of the boilers is provided with a valve, situated in the uptake, so that it can be shut off from the funnel. The outside diameter of the funnel casing is 14 feet 10 inches, and the height of the funnel above the grate is about 110 feet.

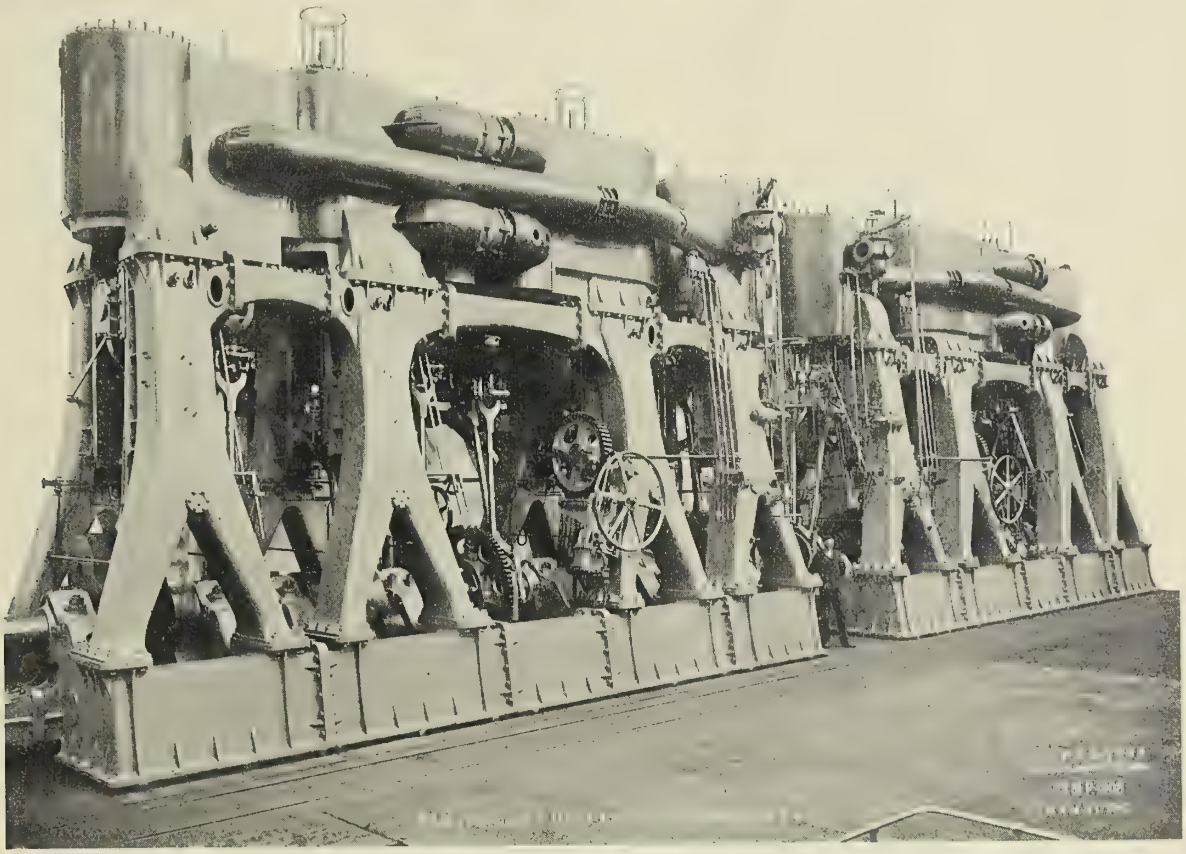
The capacity of the coal bunkers is 2,160 tons, sufficient for about fourteen days at maximum speed and a distance of 5,000 miles. The bunkers are arranged so that the coal can be handled in the most convenient manner.

AUXILIARIES.

The auxiliary condenser has 1,100 square feet of cooling surface, and is placed about 8 feet above the floor level at the starboard side of the engine room. The circulating water can be pumped through the condenser either by the main circulating pumps or by the ballast pump. A separate air pump draws the water from the condenser and discharges it into a floating tank, a vacuum of about 80 percent being maintained. The ballast pump is 10½ by 12 by 10 inches; the three donkey pumps are 13 by 9 by 10 inches. There are three drinking-water pumps, one of 10 tons capacity per hour and two of 5 tons per hour. Two fresh-water condensers, each capable of producing 15 tons of drinking water per twenty-four hours and one evaporator producing 45 tons per twenty-four hours, are also provided.

The generating plant includes four generating sets, each giving an output of 40 kilowatts. Three sets are located in the engine room between the thrust shafts, the fourth above the waterline on the main deck. The dynamos are driven by compound engines, 10 by 16½ by 7 inches, running at 250 revolutions per minute. The engines were built by the Norddeutsche Maschinen- und Armaturenfabrik, at Bremen, and differ somewhat in appearance from those usually fitted on board the ships. The large main switchboard has twenty-three circuits, of which five are police circuits, one for wireless telegraphy, seven for general lighting purposes, one for the gymnasium, one for lifts, four for ventilator motors, one for motors in the galley, and three for illuminating the ship. The lighting installation is arranged on the single-wire system, except 30 feet round the compasses, where double wires are provided. The police circuits are arranged so that they can be operated independently from a switchboard placed near the emergency dynamo. There are in all about 2,500 lights, of the tantalum type with swan sockets.

There are two refrigerating machines, of Messrs. J. & E. Hall's make, capable of reducing the temperature of the insulated chambers from 70 to 20 degrees F. in about twelve hours. Ten cold cupboards and three drinking-water coolers are provided for pantries, the capacity of the refrigerating rooms being 10,000 cubic feet for provisions, and 30,000 cubic feet for cargo. The cooling is effected by a CaCl solution, which is circulated by three vertical pumps, 4¾ by 6½ by 6 inches. The temperature of each refrigerating room, including cupboards, can be regulated by valves inserted in the brine return pipes close to the evaporators.



MAIN ENGINES OF THE CLEVELAND.

The ship is ventilated chiefly by artificial means, each first class cabin having an air trunk with a regulating slide for the supply of fresh air. Passages, lavatories, crew and emigrant spaces are all ventilated artificially, either by supplying fresh air or drawing off the foul air, as the room may require. The fans are all of the centrifugal type, and electrically driven, the motors having starting resistance with an automatic cut-off switch.

The ship is efficiently heated, according to the available space, by steam radiators or copper pipes, which harmonize with the scheme of the decoration. In the staterooms electric heaters are provided.

Loud-speaking telephones connect the navigation bridge with the engine room, forecastle, poop and crow's nest. The electric current for these telephones is taken from the ship's dynamos, and reduced by a resistance from 110 to 12 volts. The first class cabins are also provided with telephones of the ordinary type for intercommunication.

The ship is fitted with a station for wireless telegraphy, the installation of which is carried out according to the latest experience of the Compagnie de Telegraphie sans Fil, Brussels.

The installation of the anchor gear is made by Messrs.

Clarke Chapman & Company, Ltd., Gateshead-on-Tyne. There are two cable holders for working the anchor cables, which are 3⅛ inches in diameter. The dimensions of the windlass are 15 inches diameter of cylinder and 13 inches stroke. Two capstans for warping are furnished by the Norddeutsche Maschinen- und Armaturenfabrik, Bremen. Each capstan has a separate engine with two cylinders of 12½ inches diameter and 12⅝ inches stroke. The engine is fitted with a link-motion reversing gear, and drives the capstans by a worm and wheel.

The steering gear, supplied by the Norddeutsche Maschinen- und Armaturenfabrik, Bremen, turns the rudder by means of a chain, fastened to the rudder quadrant. The reversing valve is operated by telemotor from the navigation bridge, but it can also be worked by hand from the poop. If the steering engine is out of order the rudder can be moved either by a hand gear or by a steam winch, suitably placed for this purpose.

PASSENGER ACCOMMODATIONS.

The *Cleveland's* passenger accommodations have received most careful consideration, and owing to the spaciousness of the public rooms, decks for promenade, staterooms, passageways, etc., she will be classed among the the finest passenger vessels afloat. The decorations throughout have been placed in the hands of the best artists, and they will be carried out in a quiet and refined taste, similar to the exquisite style of decoration found on the steamers of the *Kaiserin Augusta Victoria, Amerika* and *Deutschland* type. Provision is made for 250 first class, 392 second class, 494 third class, and 2,064 fourth class (German law) passengers, which, with a crew of 360, makes a total of 3,560 persons.

The first class passengers are placed amidships, almost entirely in the superstructure extending over four decks (the saloon, upper, bridge and promenade). The staterooms, with a very few exceptions, have only lower berths, and are of unusually large size. The various decks are connected by means of a grand stairway and a somewhat smaller staircase, and by a separate passenger lift running from the saloon to the promenade deck.

On the promenade deck, in front of the hall, three en suite rooms, consisting of drawing rooms, bed rooms and separate baths, have been provided, having brass bedsteads of special design with no folding berths above. On the bridge deck, in the center of the ship, four special suites have been arranged. Aft on the bridge deck, on each side of the vessel, are two more staterooms with separate baths, and also two single-bed staterooms with baths. Besides these a great number of single and two-berth rooms have been built and carefully fitted with well-selected and finished furniture.

The first class dining saloon on the saloon deck measures about 3,250 square feet, and has seats for 225 passengers at small round tables. The entire floor has been covered with carpet, and incandescent lights of the Globe pattern with bronze mountings, fitted underneath a white enameled ceiling, together with table lamps of a very luxurious pattern, serve to give the room a very pleasing appearance. It has been arranged to give dinners à la carte.

The social hall on the promenade deck, into which the grand staircase leads, measures about 1,300 square feet, and seats about sixty persons. Two desks have also been provided for the hall, and two more are fitted in a special writing-room at the after end of the hall. Between the boiler and engine casing on the promenade deck the music and ladies' saloon is situated. Aft of the engine room casing on the promenade deck, the first-class smoking room of 950 square feet, is reached by a beautifully decorated vestibule, connecting the hall, the music room and the smoking room, as well as by a large staircase leading from the lower deck. Also, entrances have been arranged leading to the open-air promenade and to a bower at the after end of the smoking room. From the vestibule the gymnasium and, by a ladder to the boat deck, the Marconi house is within handy reach for the passengers.

The second class accommodations are similar to the first class, with the exception that the second class public rooms are situated in the after end of the vessel. The dining saloon on the saloon deck, a ladies' room on the upper deck, the lower smoking room and one deck above the upper smoking room, with bar, etc., attached, should give complete satisfaction to any pretentious passenger. In former years such comfortable accommodations on an Atlantic liner would have been considered fully worthy of first class passengers.

The second class dining saloon, which measures about 2,700 square feet, and seats 210, is on the same deck as the first class dining saloon, and is located the same distance aft of the center of the ship as the first class saloon is forward of the center. The after end of the saloon forms one bulkhead of the second class entrance, reaching from port to starboard, with large doors in the shell plating for embarking purposes. In this room the old-style long tables and fixed seats have been fitted.

On the upper deck aft, in a steel house, the ladies' saloon is reached from the cabins below by means of the main staircase. Aft of the main stairs, on the same deck, is the second class smoking room. The top of the above-mentioned steel house, reaching from port to starboard, gives about 10,190 square feet of promenade deck for the second class passengers. From this deck the second class upper smoke room, which is in a separate steel house, may be entered. All second class public rooms, with the exception of the dining saloon, have large square windows in brass frames, thus giving plenty of daylight and fresh air. There is little difference between the first and second class staterooms. The cabins are paneled in white, and mahogany furniture has been fitted throughout.

The third class passengers are accommodated in rooms containing two, four and six in the forward end of the vessel in the lower, 'tween and main decks, of which the main-deck cabins are portable. A large dining saloon, with long tables and revolving chairs, is situated on the main deck, with seats for 234 people. The third class passengers have a promenade fore and aft of the bridge on the upper deck, entirely covered by awnings.

Eleven compartments are fitted in the lower, 'tween and saloon decks to accommodate about 2,064 fourth class passengers, according to German law. Fixed ladders as well as portable ones lead down the hatches for communication between the compartments and the upper deck promenade. Each of the compartments has its quota of seats and tables as well as cupboards for the comfort of the passengers. Large toilets have been arranged on the upper deck, with baths and shower baths. For communication from the forward to the after end of the vessel a wide passage leads through the bridge on the port side, also serving the crew's quarters, which are situated along this side.

For passengers and crew, three physicians, two attendants, two pharmacies, one operating room, two cabin hospitals with four beds, and five other rooms with beds and the necessary baths, are provided near the center of the ship. The following arrangements have also been made for the benefit and comfort of the passengers on board: Wireless telegraphy on the boat deck, gymnasium on the promenade deck, electric light bath on the bridge deck, bookseller's shop on the bridge deck, inquiry office on the bridge deck, barbershop and ladies' hairdressery on the upper deck, with separate entrance for second class passengers, dark room on the upper deck, printing office on the saloon deck.

The first class galley, pantry, confectionery, butchery, bakery, knife-cleaning room and the necessary sculleries, are situated on the port side on the saloon deck, and are fitted with

all the latest mechanical devices. Special pantries have been provided for the different houses in the other decks of the vessel as well. An important function in connection with the culinary rooms is the placing of provision stores and cold lockers. From the same deck on which the galleys are situated, and from the same working passage, an electric lift for goods runs down to the stores. The second class galley is treated in the same manner as the first, and is situated on the same deck near the second class saloon. The third class passengers have their own galley on the upper deck, forward, which is in due connection by means of a lift to the third class pantry below and with the saloon. There is also a fourth class galley, and separate from these a Kosher (Jew) galley.

Besides the watertight bulkheads and the cellular double bottom the following safety arrangements have been fitted: Sixteen lifeboats and ten collapsible boats on the boat deck and housetops, hanging in Welin quadrant davits; life-belts for every passenger, submarine signals, Lloyd Stone's hydraulic bulkhead doors, large steam pumps, fire bulkheads in the erections above the saloon deck, steam and water fire extinguishing plants throughout the ship, loud-speaking and ordinary (for first class cabins) telephones.

The sister ship of the *Cleveland,* the *Cincinnati,* was launched from the yards of F. Schichau, at Danzig, on July 27, 1908, and it is expected that she will make her maiden trip to New York in May, 1909.

MARINE ENGINE DESIGN.

BY EDWARD M. BRAGG, S. B.

The yokes, Fig. 52, should be figured as beams supported at the ends and loaded at the middle with the load L. The surface of the valve stem guide in the case of single valves, and of the valve-yoke guide in the case of twin valves, should be such as to keep the unit bearing pressure, due to the load P, between 70 and 100 pounds.

The diameter of the eccentric rods and drag rods at the middle should be figured by the connecting rod formula, as

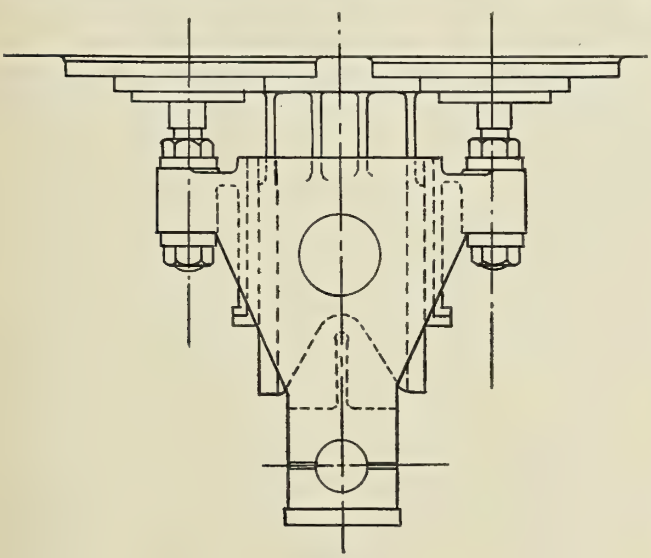


FIG. 52.

they are columns hinged at the ends. The diameter of the drag rods at the ends can be made three-fourths of their diameter at the middle. The diameter of the eccentric rods at the top should be 0.9, and at the bottom 1.1 of the diameter at the middle. The length of the drag rods is usually from $15E$ to $18E$, and of the eccentric rods $20E$ to $30E$ for merchant engines and $15E$ to $20E$ for naval engines. The diameter of the bolts in the caps, etc., should be such as to carry the loads with the factors of safety given in Table IV.

The link is usually of the double-bar type, Fig. 53, and is figured as a beam supported at the ends and loaded at the middle with the load L; as mentioned before, the length of the beam, or distance between eccentric rod pins, a, is usually $6E$. The breadth of the bars b is usually about one-third of the depth c, and the depth is so chosen that the factor of safety

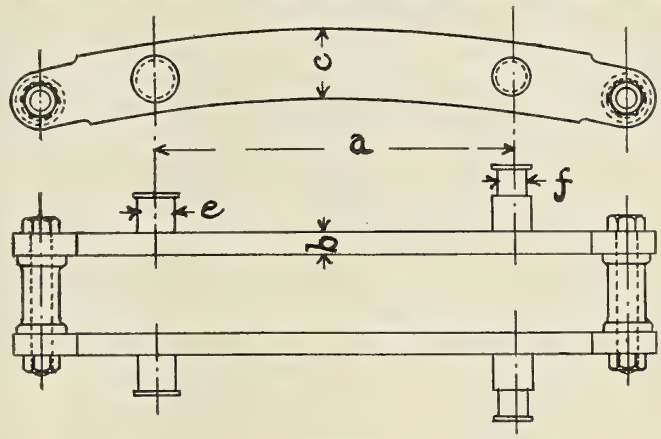


FIG. 53.

will be 12, as the load is alternating. Making this assumption in regard to the relation of breadth and depth, the formula for the depth of each link bar becomes:

$$h = \sqrt[3]{\frac{9La}{4f}}, \qquad (60)$$

where L = load upon valve gear;
a = distance between eccentric rod pins;
and f = allowable stress with factor of safety of 12.

The diameter d of the link block pin, Fig. 54, is from 0.9 to 1.0 of the depth of the bar c; the diameter of the eccentric rod pins e, Fig. 53, is about three-fourths the depth of the link bar, and the diameter of the drag link pin f is about three-fourths the diameter of the eccentric rod pin. The lengths of all these pins, as well as that of the block gibs g, must be such as to keep the bearing pressures within the

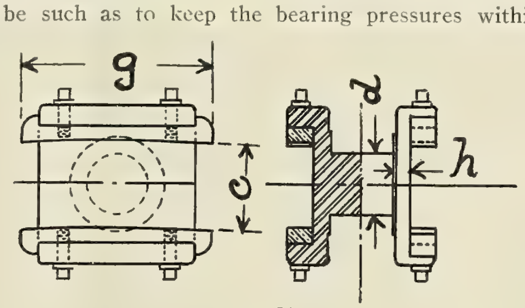


FIG. 54.

limits given in Table VII. The thickness of the metal h joining the link block pin at the sides to the sliding gibs should be from 0.25 to 0.3 of the diameter of the link block pin d.

The diameter of the eccentric will be:

$$D = 2(r + E + c), \qquad (61)$$

where r = radius of eccentric pad on crank shaft;
E = the eccentricity;
$c = \frac{r}{3}$, if the lower part of the eccentric is made of cast iron,
and $= \frac{r}{4}$ if it is made of cast steel.

The upper part of the eccentric, Fig. 55, is always made of cast iron, and joined to the lower part by bolts or collar studs. The keyway should be cut on a line at right angles to the joint

of the two parts, so that the eccentric can be readily taken off. If the eccentric is so situated that it can be moved along the shaft clear of the key, then the keyway can be on the side, as shown dotted in Fig. 55, and the set screw more conveniently located.

It is well to make the keyway considerably broader than the key in the shaft, and to fit liners on either side, so that slight

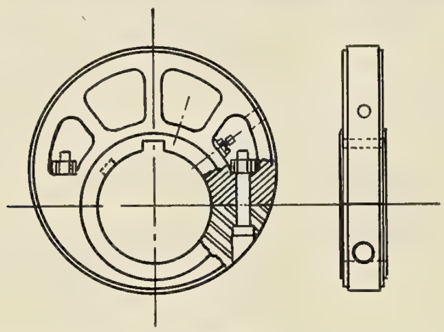


FIG. 55.

changes can be made in the angular advance, if it is thought best. The breadth of the eccentric should be sufficient to keep the bearing pressure within the limits given in Table VII.

The eccentric strap, Fig. 56, should have lips fitting on each side of the bearing surface of the eccentric sheaves, to keep the strap in place. The strap bolts should be designed to carry the load L coming upon the valve gear, as should also the bolts uniting the eccentric rod to the strap. The straps are usually made of cast steel lined with white metal, and the section of the lower half, exclusive of the white metal, should be sufficient to carry the load L with a factor of safety of 8.

The reverse shaft levers, Fig. 51, should be figured for the load $2P$ upon the drag rods, and should be of such a length

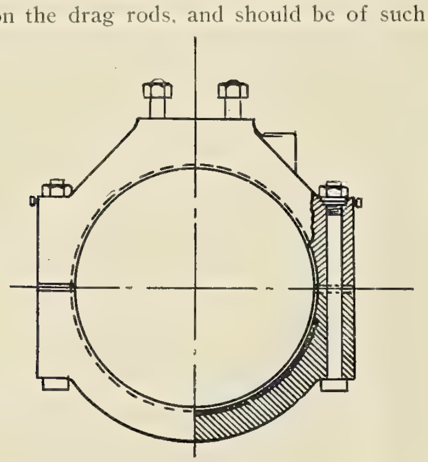


FIG. 56.

that the angle moved through is not more than 80 degrees. The "gag" upon the lever should be so arranged that, in the backing position, the center line of the screw is vertical. This will cause the position of the link, when backing, to be practically the same, irrespective of the position of the end of the drag rod in the slot. In the ahead position of the lever the gag screw will be nearly horizontal, and the link can be pulled in an amount about equal to the travel of the nut on the thread.

The reverse shaft should be figured for torsion and bending, due to the thrust of the drag rods. As it is not always possible to get the bearings close to the various reverse shaft levers, the bending moment may be large in these shafts. The equivalent twisting moment should be found by formula 36. The twisting moment T used in this formula should be that coming upon the portion of the reverse shaft nearest the reversing engine. The reversing engine is usually placed near the middle of the length of the main engine, and it is generally safe to figure the shaft for the twisting moment necessary to move the low-pressure gear; for when these links make the greatest angle with the horizontal plane the other links are in a more advantageous position. In the preliminary design the bending moment can be neglected, and the factor of safety increased from 12 to 15 to allow for this neglect. After taking off the medium-pressure reverse shaft levers, the size of the shaft running to the high-pressure levers can usually be decreased.

In using formula 52, the weight of the valves, valve stems, cross-heads and blocks is usually obtained from data for similar engines. If no such data are available, Fig. 57 can be used to get the weight of valves for purposes of calculation. The ordinates of the curve are the weights of the valves divided by the eccentricity, so that the weight of any diameter

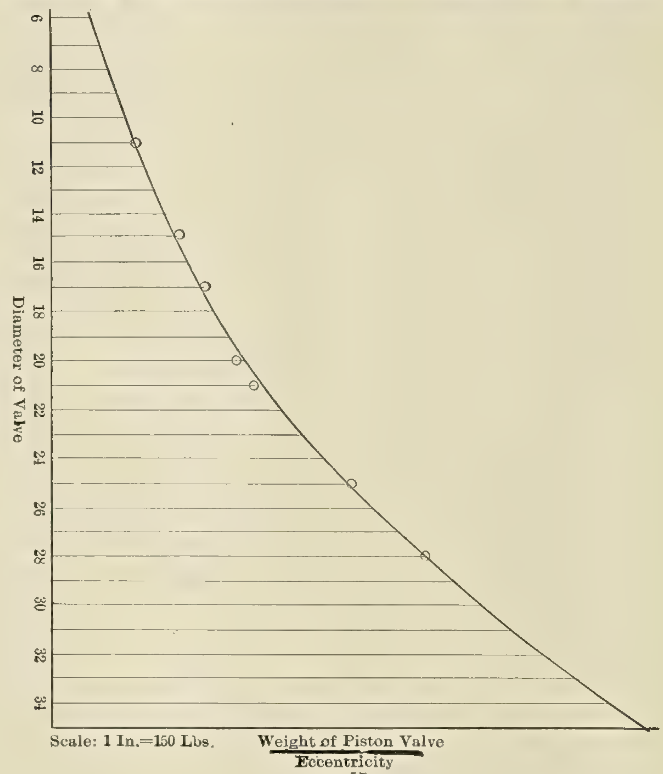


FIG. 57.

of valve can be obtained approximately by multiplying the quantity in Fig. 57 by the eccentricity used. The weight of the other parts can be calculated roughly.

Calculations.—Assumed weights of valve gear are as follows:

High-pressure (12 inches diameter):	
1 valve	325 pounds.
1 s em	350 pounds.
1 block	100 pounds.
	775 pounds.
Medium-pressure (two 17 inches diameter):	
2 valves	1,020 pounds.
2 stems	500 pounds.
1 crosshead	325 pounds.
1 block	100 pounds.
	1,945 pounds.
Low-pressure (two $27\frac{1}{2}$ inches diameter):	
2 valves	2,650 pounds.
2 stems	500 pounds.
1 crosshead	400 pounds.
1 block	100 pounds
	3,650 pounds.

Formula (54):

$L = [3 + (0.00002837 \times 4.75 \times 120^2)]3{,}650 = 18{,}100$ for low-pressure.

$= [3 + (0.00002837 \times 4.25 \times 120^2)]1{,}945 = 9{,}100$ for medium-pressure.

Formula (59): $P = \dfrac{18{,}100 \times 0.7431}{3} = 4{,}475$ for low-pressure.

$P = \dfrac{9{,}100 \times 0.7}{3} = 2{,}125$ for medium-pressure.

Assume length of drag rods $= 16E = 68$ inches.

Assume length of eccentric rods $= 22E = 94$ inches (approximately).

$$f = \frac{60{,}000}{12} = 5{,}000 \text{ pounds per square inch.}$$

Drag Rods—Low-pressure Gear.

Formula (27):

$$F = \frac{2 \times 4{,}475}{\pi \times 5{,}000} = 0.572$$

$$D^2 = \sqrt{\frac{1.08 \times 0.572 \times 60{,}000 \times 68^2}{10{,}000{,}000} + 0.327} + 0.572 = 4.76$$

$D = 2.18$ inches (use $2\frac{1}{4}$ inches) at middle of length;
$2.25 \times 0.75 = 1.69$ (use $1\frac{3}{4}$ inches) at ends.

From Table IV., the load, 4,475 pounds, requires two 1-inch bolts to be used in the drag rod caps.

Eccentric Rods—Low-pressure Gear.

$$f = \frac{70{,}000}{12} = 5{,}840;$$

$$F = \frac{2 \times 18{,}100}{\pi \times 5{,}840} = 1.98$$

$$D^2 = \sqrt{\frac{1.08 \times 1.98 \times 70{,}000 \times 94^2}{10{,}000{,}000} + 3.96} + 1.98 = 13.65$$

$D = 3.69$ inches (use $3\frac{3}{4}$ inches) diameter at middle of rod;
$3.75 \times 0.9 = 3.38$ (use $3\frac{3}{8}$ inches) diameter at top of rod;
$3.75 \times 1.1 = 4.13$ (use 4 inches) diameter at bottom of rod

The low steam speeds used and the large low-pressure valve resulting, together with the larger eccentricity, make the low-pressure eccentric rods larger than we care to use on the medium-pressure and high-pressure gears, so the rods for the latter will be calculated from the medium-pressure weights and eccentricity.

With $L = 9{,}100$, $E = 4.25$. Formula 27 gives the diameter at middle of medium-pressure and high-pressure eccentric rods $= 3$ inches; diameter at upper end of medium-pressure and high-pressure eccentric rods $= 2\frac{3}{4}$ inches; diameter at lower end of medium-pressure and high-pressure rods $= 3\frac{3}{8}$ inches.

Links.

Formula (60):

$$h = \sqrt[3]{\frac{9 \times 18{,}100 \times 28.5}{4 \times 5{,}840}} = 5.83 \text{ (use } 5\tfrac{3}{4} \text{ inches) for depth of link bar.}$$

Breadth of link bar $= \dfrac{5.75}{3} = 1.92$ inches (use 2 inches).

Diameter of link block pin
$= 5.75 \times 0.9 = 5.18$ inches (use 5 inches).

Allowable load, Table VII. = 800.

$$\frac{18{,}100}{750 \times 5} = 4.83 \text{ inches (use 5 inches for length of pin).}$$

Length of link block gibs

$$= \frac{18{,}100}{2 \times 2 \times 300} = 15 \text{ inches.}$$

Thickness of metal joining link block pin and gibs
$= 5'' \times 0.3 = 1.5$ inches.

Diameter of eccentric rod pins
$= 5 \times 0.75 = 3.75$ inches.

Length of eccentric rod pins

$$= \frac{18{,}100}{2 \times 3.75 \times 750} = 3.22 \text{ inches (use } 3\tfrac{1}{4} \text{ inches).}$$

Diameter of drag rod pins
$= 3.75 \times 0.75 = 2.82$ inches (use 3 inches).

Length of drag rod pins

$$= \frac{4{,}475}{3 \times 500} = 2.98 \text{ inches (use 3 inches).}$$

Diameter of low-pressure eccentric, which is on a coupling, (see Figure 46), $= 2(11.625 + 4.75 + 3.25) = 39.25$ inches.

Diameter of medium-pressure and high-pressure eccentrics. $= 2(6.375 + 4.25 + 3.25) = 27.75$ inches.

Width of low-pressure eccentric $= \dfrac{18{,}100}{150 \times 39.25} = 3.08$ (use 3 inches). Allowing for $\frac{1}{2}$-inch lip on each side, the total breadth of low-pressure eccentric and strap = 4 inches.

Width of medium-pressure and high-pressure eccentrics $= \dfrac{9{,}100}{150 \times 27.75} = 2.19$ (use 3 inches). Allowing for $\frac{1}{2}$-inch lip on each side, the total breadth of high-pressure and medium-pressure eccentric and strap = 4 inches.

Diameter of bolts and studs in eccentric sheaves, see Fig. 56, to be 2 inches, see Table IV.

In order that the reverse shaft levers may not have to move through an angle greater than 80 degrees, the length of the levers should be:

$$\frac{4.75 \times 6}{2 \times \sin 37^\circ 30'} = \frac{14.25}{0.61} = 23.4 \text{ inches (use } 23\tfrac{1}{2} \text{ inches).}$$

We will place the reversing cylinder between the low-pressure and medium-pressure cylinders, and figure the reverse shaft for the twisting moment from low-pressure gear.

$T = 2 \times 4{,}475 \times 23.5 = 210{,}000$ inch pounds.

$$f = \frac{70{,}000}{15} = 4{,}670 \text{ pounds.}$$

$$D = \sqrt[3]{\frac{210{,}000 \times 5.1}{4{,}670}} = 6.12 \text{ inches (use 6 inches) for the diameter of the reverse shaft.}$$

Assuming that the turning moment necessary to reverse the high-pressure gear is one-half that for the low-pressure gear, the size of shaft beyond where the medium-pressure reverse shaft levers are taken off can be made 5 inches.

An error in the article "Recent Additions to the British Fleet," published in our January issue, has just been brought to our attention. The article stated that although the old *Inflexible* had two turrets mounted *en echelon*, all the guns could not be fired on both broadsides, whereas in the new *Inflexible* all the guns mounted *en echelon* on the upper deck could be trained to fire on either side of the ship. As a matter of fact, the deck plan of the old *Inflexible* shows three separate erections on the main deck—one at the bow, one at the stern and one in the center of the ship. These were connected by narrow bridges, and there was ample space between the separate parts of the superstructure to train the guns in either turret across the ship.

A NEW TYPE OF TORPEDO BOAT.*

BY HUDSON MAXIM.

A little while ago, the Whitehead automobile torpedo was thought to be a valuable adjunct to the armament of the modern battleship, but the range of the guns has now been so increased that such torpedoes become a useless incumbrance, because of the shortness of their range, notwithstanding the fact that their manufacturers have done everything possible to perfect them and to increase their speed and range. Their range is necessarily limited to that attainable by the charge of compressed air they are capable of carrying.

During the past few years, the air pressure has been increased from 1,300 pounds to the square inch to 2,250 pounds to the square inch, and the weight of air from 60 pounds to 130 pounds in the 18-inch torpedo; and still the maximum range of the 18-inch torpedo is only from 3,000 to 3,500 yards, practically about one-third of the range of the high-power guns which determines the distance apart of the lines of battle; and the maximum rate of speed of this torpedo is about 35 knots.

In order to carry the air under the enormous pressure, a very strong and very heavy steel air flask is needed; and as the weight of the entire torpedo must not exceed the weight of the water displaced by it, the propelling mechanism has necessarily to be made very light and delicate for the energy it has to transmit.

But what is far more important, the explosive charge also has to be reduced to a minimum, in order to float the heavy air-flask and the weight of air it contains; and this notwithstanding the fact that the quantity of high explosives ought to be greatly increased in order to ensure destruction of the warship struck by it. In the recent war between Russia and Japan, the Whitehead torpedo proved a great disappointment.

If the speed of an automobile torpedo could be increased 50 percent, its accuracy also would be greatly increased, for it would be far less affected by currents, and would be far more likely to strike a moving target, while if its range could be increased 100 percent, it would then become an efficient adjunct to the armament of every war vessel, whereas if its range could be increased to 5 miles—practically three times what its range now is—even though its speed were to remain at 35 knots, it would be able to pass over the intervening space separating the lines of battle of opposing fleets.

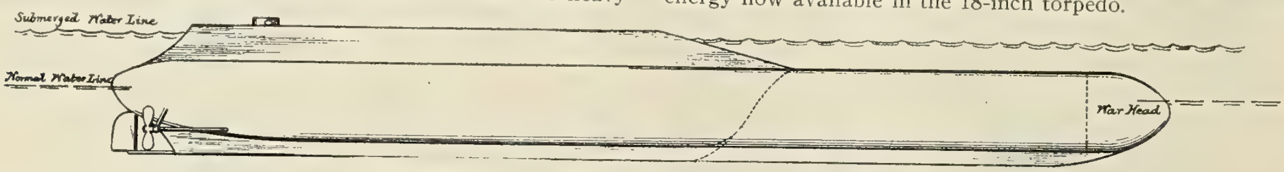
During the last ten years I have conducted a large number of experiments at a cost of more than $50,000 in the development and demonstration of a system for the propulsion of automobile torpedoes and torpedo boats by energy derived from the products of combustion of a self-combustive fuel called motorite, consisting of 70 percent nitroglycerin and 30 percent guncotton. The guncotton is gelatinated by the nitroglycerin, forming a dense, tough and rubbery material. This material is made into bars about 7 inches in diameter and 6 feet long, for use in torpedoes the size of the 18-inch Whitehead torpedo. For the 21-inch torpedo, the stick will be both bigger and longer.

The motorite bars are forced into and sealed in steel tubes for use, and these steel tubes containing the motorite are inserted into the torpedo and are surrounded by a water-jacket. The motorite can be ignited and can burn only at and from one end, and water is forced through the water-jacket into the combustion chamber, to be evaporated by the flame blast forcing the water along with it through an atomizing device, whereby it is instantly converted into steam, and the combined steam and products of combustion form the motive fluid.

The water will be taken in from the sea as required, so that it will not be necessary to carry the water supply on board the torpedo.

One pound of motorite evaporates a little over two pounds of water, so that one pound of motorite produces the equivalent of three pounds of steam, for the products of combustion of the motorite mingle with the steam produced. The steam from the combustion chamber is conducted to turbines, or other engines or devices for propelling the torpedo through the water. By means of this system of propulsion, the range of the automobile torpedo can easily be doubled, while at the same time its speed can be increased 50 percent. The heavy air-flask will be done away with and will be replaced by a shell merely strong enough and heavy enough for structural rigidity.

This will enable the carrying of 160 pounds of motorite in place of the 130 pounds of air now carried, and as each pound of motorite will evaporate two pounds of water, we have available 480 pounds of motive fluid; and as steam and the products of combustion of motorite are much more efficient as a motive fluid per unit of weight than compressed air, it is safe to assume that we have available four times the energy now available in the 18-inch torpedo.



PROPOSED DESIGN FOR A SUBMERSIBLE TORPEDO BOAT WITH A DESTRUCTIBLE BOW.

Instead of carrying but 200 pounds of wet guncotton—the present charge—we should be able to carry 300 pounds of Maximite, which is practically twice as powerful per unit of weight as guncotton, while its density is 50 percent greater than that of guncotton, so that we should have a warhead easily three times as powerful as the present warhead.

The thing most needed at the present time is a torpedo boat capable of passing unscathed through the fire of quick-firing guns of a battleship in order to get near enough to reach her with certainty with torpedoes carrying a sufficient quantity of high explosives in the warhead to ensure her destruction when hit.

I am strongly of the opinion that the most effectual way of accomplishing this result is to construct a torpedo boat in the following manner:

Build the hull of the boat somewhat on the lines of the cigar-shaped automobile torpedo. Even a perfect counterpart of the torpedo in shape would serve the purpose well; but I would suggest a little greater vertical than horizontal diameter. In other words, I would build the boat a little more fish-shaped than the torpedo, and I would construct it so that it would be adapted to travel both upon the surface of the water and in a semi-submerged position, or rather, in a nearly submerged position. I would drive the boat with gasoline engines under normal conditions, and when going into action—that is to say, in making the run of attack—the boat would be in its nearly submerged position and would be driven by the combined power of the gasoline engines and motorite.

The gasoline engines will be provided with a shift gear, something like that employed on automobiles, so that under normal conditions—that is to say, when the boat is propelled along the surface of the water by the gasoline engines alone—the propellers will be driven at a slower speed, and a speed

* From a paper read before the American Chemical Society, New York, October, 1908.

adapted to the speed of the boat thereby secured; but when going into action in a submerged position and traveling at possibly double the speed, the gear will be shifted so that the propellers will travel at a speed commensurate with the higher speed of the torpedo boat.

The boat will be provided with a top keel or fin a little thicker than a man's body across the shoulders at the rearward end, being narrowed down forward, and a conning-tower large enough for a man to stand erect. The front end of the superstructure will be sharp, and water will be thrown to right and left and will not obscure the forward view of the occupant of the conning-tower. The superstructure will be subdivided into small compartments, filled with cellulose. The partitions between the compartments will be thin sheet metal. The whole superstructure, except the conning-tower, will be very light and entirely dispensable, and can be shot away without actual damage to the boat itself. The superstructure will be for flotation purposes only, serving to tie the boat to the surface of the water, while the boat itself will be actually submarine. The superstructure will project above the surface of the water about a foot. The conning-tower will be protected by thin armorplate thick enough to resist the projectiles of small quick-firing guns, and there will be no danger of being hit by guns of a larger caliber.

It will be extremely difficult to hit either the superstructure or the conning-tower, even with small, quick-firing guns, for the conning-tower will not be more than two feet above the surface of the water, and will not exceed three feet in diameter, and will be moving forward at the rate from 40 to 60 miles an hour.

Of course, it will require stupendous energy to propel a submarine boat through the water at so high a rate of speed, and there is nothing available known to me except motorite which can supply the required energy. With motorite, however, we have easily all the energy that may be required for any desired rate of speed until the motorite is entirely consumed. Enough motorite can easily be carried to drive such a submarine boat at a speed of sixty miles an hour for a distance of 30 miles. This will be sufficient to overtake and sink any battleship that might be sighted. Of course, a speed of 45 miles an hour can be maintained for a much longer time, probably for an hour and a half, with the same quantity of motorite.

The Whitehead torpedo is in reality a sort of submarine torpedo boat, and what is true of it also holds true of the torpedo boat I propose. Of course, the keel and superstructure in the boat I propose would offer additional resistance, but on account of the larger size of the boat and its greater length and the enormous quantity of motorite that may be carried, we shall have available more than enough energy to make up for the increased resistance.

The boat will carry, say, a couple of torpedoes in the prow and launch them when getting within close range of a warship. These torpedoes should each carry at least 500 pounds of high explosive. It would be better if they carried half a ton each in the warhead.

I have shown how a torpedo boat may be made so that it may be safely run through the zone of fire of a battleship to launch its torpedoes at close range. I am, however, of the opinion that a far better way, and one which will be adopted in the near future, will be to employ a torpedo boat which shall itself constitute an enormous torpedo. It will be a species of ram; but instead of depending upon the steel prow for punching a hole in a warship, it will be armed with a ton of high explosive. The boat will be made, say, 300 feet in length over all, and 100 feet of the forward portion of the boat will be wholly dispensable and may be blown away without injury to the boat proper, the boat proper being but two hundred feet long.

The warhead of the torpedo boat will strike the battleship below its armor belt and the blast of the explosion will be inward and upward through the warship, while the reacting blast of the explosive charge will not be very severe upon the occupants of the torpedo boat. They will be hurled back by an enormous wave of water, but it will not be a quick, sharp, destructive blow, dangerous to the occupants of the boat or to the boat itself.

After torpedoing a warship, the torpedo boat, with its dispensable bow blown off, will still be in perfect trim to retreat and escape.

Of course, this torpedo boat will not supplant the automobile torpedo, for that will be employed in other evolutions; but for the direct run in upon a warship, this form of torpedo boat with a ton of high explosive in the warhead will be the main arm of naval service, for nothing could prevent one of these torpedo boats from selecting any battleship in any fleet and sinking it without a chance in a hundred of being prevented.

GUNBOAT BOILERS.

BY CHARLES S. LINCH.

The question is frequently asked, what is a low high-pressure boiler? In reply to these questions the attention of readers of this journal is called to the drawings herewith shown of the low high-pressure boilers installed on the Wilson Line steamboats, which are in service on the Delaware River between Philadelphia and Wilmington. This type of boiler is more frequently termed a "gunboat" boiler, for the reason that it is frequently used in gunboats or other shallow draft vessels where there is no room between the decks for the ordinary type of Scotch boiler. In the gunboat boiler the furnaces lead to a common combustion chamber, from which the boiler tubes extend to the back head of the boiler. Thus the construction of a gunboat boiler is very similar to that of a Scotch boiler, while the diameter is very much less.

The two Wilson line steamers, *Brandywine* and *City of Chester,* were built by the Harlan & Hollingsworth Corporation, at Wilmington, Del., the *Brandywine* in 1883 and the *City of Chester* in 1888. The *Brandywine* is 177½ feet long, with a molded beam of 25.1 feet, and she is driven by a single four-and-aft compound engine, having cylinders 21 and 42 inches in diameter, with a stroke of 24 inches. The boilers originally installed on this boat were in service until 1905, when it was found that the furnaces and combustion chambers would have to be replaced, although the shells were in perfect condition. It was found that the cost of tearing the old boilers out and rebuilding them would be more than the cost of entirely new boilers, and, therefore, new ones were built from similar designs. Plans for these new boilers are shown in Fig. 1. The steam pressure carried on the old boilers was 120 pounds, but when the new boilers were installed this was raised to 150 pounds, and the diameter of the high-pressure cylinder of the engine was reduced to 21 inches, making the ratio of cylinder capacities 1 to 4.

This boat has proved remarkable in many ways. In ten months she recently ran 47,750 miles with a cost for machinery repairs of only 5 cents, this expenditure being for a ¼-inch close nipple. During the summer three round trips are made per day, and in the winter one and a half trips are made daily. Her performance in the ice is considered remarkable, as it has frequently happened that when the ice boats have been unable to cut their way out the *Brandywine* has come through.

The *City of Chester* is 197 feet long over all, with a molded beam of 28 feet and a total beam outside the guards of 40 feet. She is equipped with one three-cylinder triple-expansion engine, with cylinders 18½, 27 and 42 inches in diameter and

a stroke of 24 inches. The two boilers which were originally installed on this boat when she was built in 1888 are still in service, and are still carrying the steam pressure of 160 pounds for which they were originally designed. In 1896 the combustion chambers of these boilers were increased 6 inches in length, and suspension furnaces of the Morison type were substituted for plain furnaces. Corresponding to the change in length of the combustion chamber the old tubes were reduced 6 inches in length and were replaced; but, up to the present time, only about one-third of the old tubes have been renewed.

The boilers of both the *Brandywine* and *City of Chester* are operated under forced draft, which is maintained by steam jets of the Bloomsburg type. A Bloomsburg circulator is also used in each boiler. The *Brandywine* is now equipped with a Riley feed-water heater, while the *Chester* takes her feed direct from the filter box. Each boiler is provided with main and auxiliary feed, the main feed pump being a 7 by 4½ by 8-inch Worthington duplex, and the auxiliary feed by injector.

The fuel consumption of both the *City of Chester* and the *Brandywine,* under forced draft, is 35 pounds per square foot of grate area per hour. Under natural draft it is from 20 to 22 pounds.

At the end of the season, when the boilers are opened, the interior is invariably found to be in perfect condition, without the slightest trace of grease, mud, scale or, in fact, any sign of deterioration. This fact accounts for the long life and continued efficiency of these boilers, and is due to the constant attention which they receive by the engineers in charge, since the class of work which these boats do in both summer and winter does not permit the boilers to be opened for months at a time. The machinery in these boats has proved as efficient as the boilers, which is shown in the instance of the packing in the high-pressure and low-pressure stuffing-boxes of the *Brandywine,* which was not touched for twenty-three years, while the piston rods are in perfect condition without a scratch upon them. Further evidence of the class of work turned out when these boilers were installed is shown in the accuracy of the steam gages, which have been in place ever since the boats have been in existence, and which have maintained their accuracy to the present day. These gages were manufactured by the American Steam Gauge & Valve Manufacturing Company, of Boston, Mass.

Although the requirements which these particular boilers are forced to meet are exacting, nevertheless their superiority over any other type of boiler for such service has been well demonstrated. It would be impossible to install Scotch boilers in these boats, as they would encroach upon the deck space which must necessarily be reserved for freight. A careful study of the drawings will serve to show that these boilers are not only strong and well built, but that the steam space is large as compared to that of many Scotch boilers; that is, the ratio of the volume of the steam space to the volume of the high-pressure cylinder is large. Trouble from leaky seams has not been experienced with these boilers, due probably to the fact that water circulators are fitted. The frequent claim that the low high-pressure or gunboat type of boiler is an inefficient steam generator and a poor design to use has been entirely discredited in the case of these two boats.

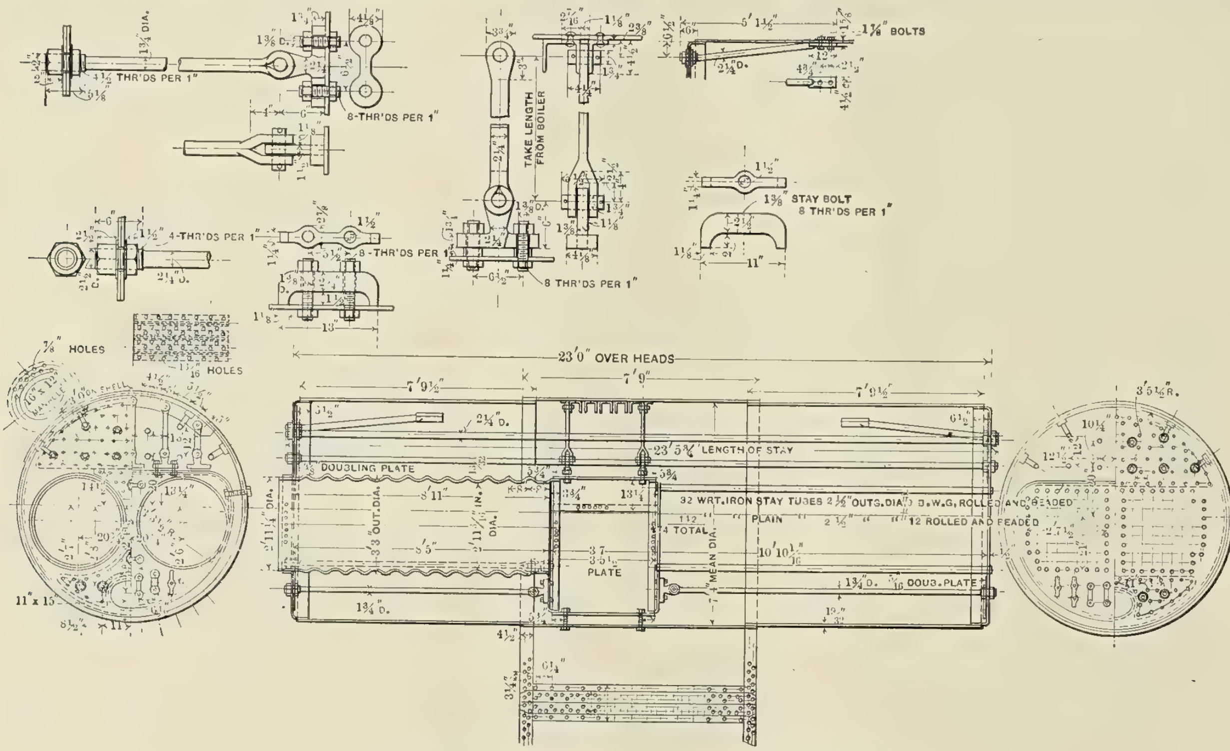


FIG. 1.—DETAILS OF GUNBOAT BOILERS ON THE BRANDYWINE.

BOILERS OF THE "BRANDYWINE."

The boilers of the *Brandywine,* details of which are shown in Fig. 1, are 23 feet long, 7 feet 4 inches in diameter, built for a working pressure of 150 pounds per square inch. The total heating surface is 1,405.9 square feet, divided as follows: Tubes, 1,234 square feet; furnaces, 98.4 square feet; combustion chamber, 58.5 square feet; tube plate, 15 square feet. The total grate surface is 39.5 square feet, making a ratio of heating surface to grate area of 35.5 to 1. The area through the tubes is 703 square inches per square foot of grate area.

The shell of the boiler is in three courses, and is 19/32 inch thick. The circular seams are double-riveted lap joints, with ⅞-inch rivets spaced 3¼ inches between centers. The longitudinal seams are triple-riveted butt joints, with the outside straps ½ inch thick and 9 inches wide, and the inside straps 14¼ inches wide and ½ inch thick. The rivets are ⅞ inch

diameter, and are spaced 3⅛ inches and 6¼ inches between centers. The percentage strength of this joint, as compared with the solid plate, is 85.8.

Each boiler has two corrugated furnaces, 3 feet 3 inches outside diameter, 8 feet 11 inches long, 13/32 inch thick; and 174 2½-inch outside diameter tubes. Thirty-two of the tubes are wrought iron stay tubes, No. 9 B. W. G.; the remaining 142 are wrought iron plain tubes, No. 12 B. W. G. The distance between tube plates is 10 feet 10 1/16 inches.

The front head of the boiler is a single sheet, ½ inch thick, flanged inwards to join the shell and outwards for the furnace mouth. The portion of the head above the furnace is reinforced by a ⅜-inch doubling plate, and the portion below the furnace by a 5/16-inch doubling plate.

The heads of the boiler are stayed by 2¼-inch through stay rods and 2¼-inch diagonal stays. The lower part of the heads is braced by 1¾-inch stay rods, fastened to the combustion chamber by two 1⅜-inch bolts, as shown in the details, Fig. 1. The staying of the combustion chamber crown sheet is accomplished by means of sling stays to the shell of the boiler, spaced 6 inches longitudinally and 6½ inches across the boiler. These stays are fastened to the crown sheet so as to leave a clear water space of 1¼ inches all over the sheet.

BOILERS OF THE "CITY OF CHESTER."

The two boilers of the *City of Chester* are each 23 feet long and 8 feet diameter. Each boiler has two plain circular furnaces, 38 inches inside diameter and 9 feet 6 inches long, with a single combustion chamber, 2 feet 6 inches deep and 204 2½ inches outside diameter tubes of No. 12 B. W. G. thickness. The total heating surface in each boiler is 1,644.5 square feet, divided as follows: Flues, 109.5 square feet; combustion chamber, 58.5 square feet; tubes, 1,457.5 square feet; back tube sheet, 19 square feet. The grate area of the boiler is 42.75 square feet, therefore the ratio of heating surface to grate area is $\frac{1,644.5}{42.75} = 38.5$ to 1. The flue area through the tubes is 5.8 square feet, and the ratio of the area of the grate surface to the area through the tubes is $\frac{42.75}{5.8}$, or 7.37 to 1.

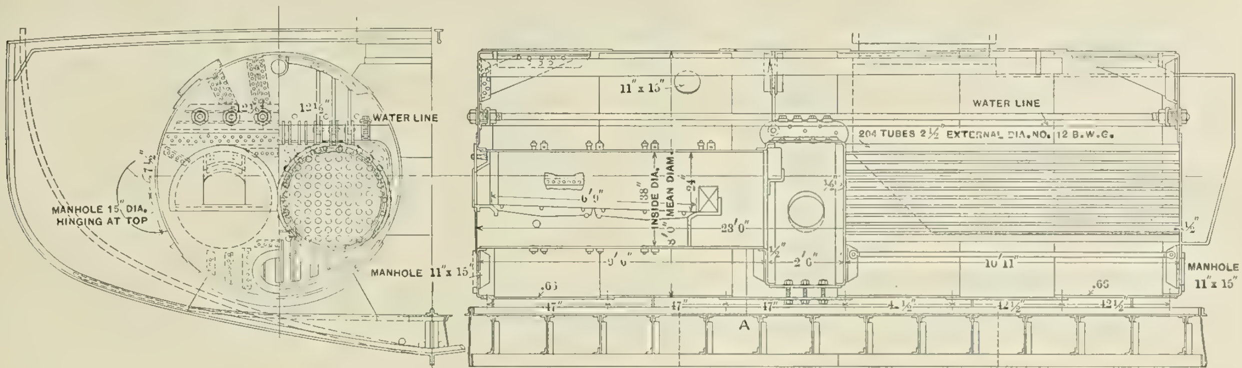


FIG. 2.—ONE OF THE GUNBOAT BOILERS ON THE CITY OF CHESTER.

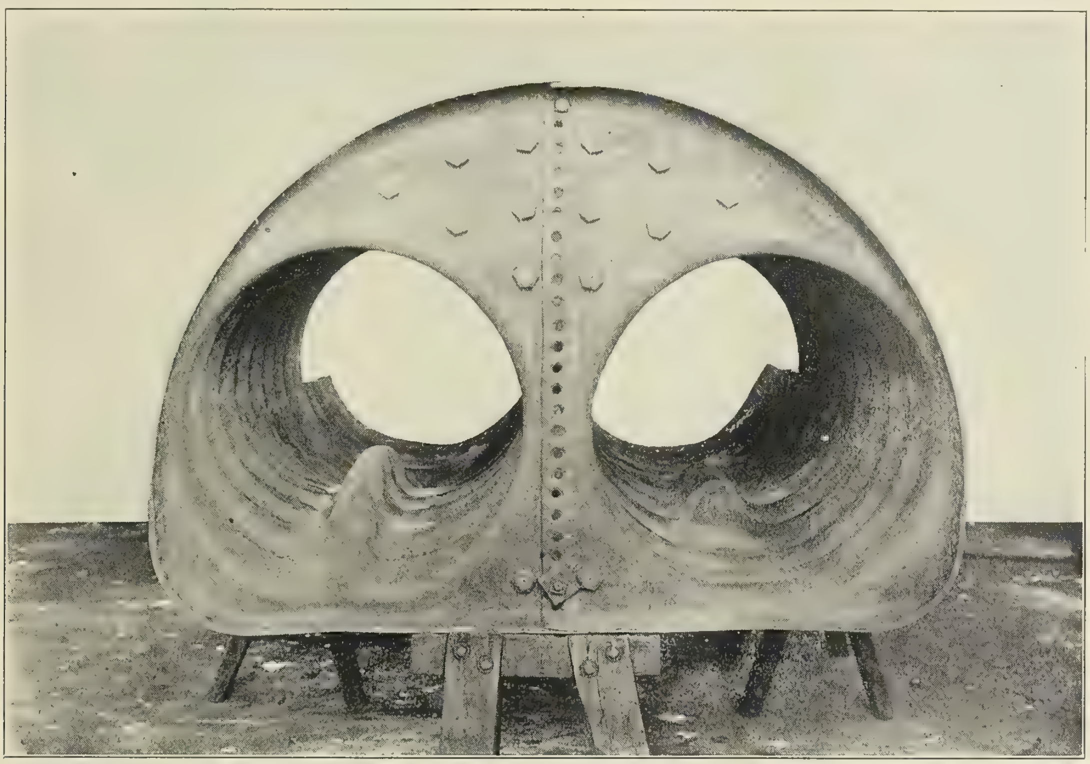


FIG. 3.—RESULT OF LOW WATER IN THE NEW BOILERS OF THE STEAMER BRANDYWINE.

The boilers were designed for a working pressure of 160 pounds per square inch. They were built of six courses of steel plate .66 inch thick. The circular seams are double-riveted lap joints, fastened with 1-inch rivets spaced 3½ inches between centers. The longitudinal seams are triple-riveted butt joints with steel butt straps, ½ inch thick, fastened with 1-inch rivets spaced 4½ inches between centers. The front head is made in two sections, the furnace sheet and the upper sheet. These are fastened together with a lap joint by ⅞-inch rivets spaced 2½ inches. Both sheets are ½ inch thick, and the furnace sheet is flanged inwards at the furnace mouth.

The furnaces themselves are plain cylindrical tubes of ½-inch plate, with single-riveted lap longitudinal joints, fastened with ⅞-inch rivets spaced 2½ inches between centers. The furnaces are stayed by means of iron rings, 3 by 1½ inches half round at the top and flat on the bottom. On the upper part of the furnace, above the grate bars, these reinforcing rings are separated from the furnace by thimbles around the rivets 1¼ inches long, leaving a clear water space outside the furnace. On the bottom of the furnace, however, these reinforcing strips are riveted fast to the plate without the intervening water space. There are four reinforcing rings on each furnace. The grates are each 6 feet 9 inches long, and terminate at a soapstone fire wall. A similar wall is also placed at the top of the furnace at the entrance to the combustion chamber, in order to protect the crown sheet thoroughly.

The combustion chamber tube plate is ½ inch thick, and is flanged inwards to join the wrapper sheet. The crown sheet is stayed by the ordinary form of girder crown bars, carrying stay-bolts 1⅜ inches diameter outside the threads and spaced 6 inches apart. The girders themselves are spaced 6¼ inches center to center. Each girder is composed of two ¾-inch plates, 6½ inches wide. The sides and bottom of the combustion chamber are supported by 1⅜-diameter threaded staybolts, spaced 6¼ inches circumferentially and 6¾ inches longitudinally. These stays are fitted with nuts, both outside the boiler shell and inside the combustion chamber.

The heads of the boiler are stayed partly by means of through stay rods of double refined iron, 2¼ inches in diameter, and partly by gusset stays of ⅝-inch plate, 10¼ inches wide, riveted to the shell and to the head by double 5 by 3 by ½-inch angle bars. Details of the method in which the through stays are fastened to horizontal angle bars on the heads are shown in the drawing.

ACCIDENT TO THE BOILERS OF THE BRANDYWINE.

On Sept. 5, 1908, while the chief engineer of the *Brandywine* was off duty, the assistant, through negligence and neglect, allowed the water to become low in the boiler with the result that the crowns of the furnaces came down, as shown in Fig. 3. No deposit of any kind was found in the boiler, so that the only reason that could be assigned for the accident is low water. At this time the feed pumps were at the shops being overhauled, and hence the injector was the only means which could be relied upon for feeding the boiler. An examination of the water-glass fittings was made, and the bottom was found clogged with mud, while the top connection contained pieces of glass, which prevented it from functioning. The engineer on watch admitted having renewed the glass without cleaning out the connection. Taking into account the surface, which was at a high temperature at the time of the accident, if water had been put into the boiler it is probable that the safety valves and engines would not have taken or reduced the volume of steam to a point to prevent rupture. The material of which the furnaces were made was of splendid quality and showed high physical properties.

ANCHORS.

BY J. M. BULKLEY.

The constituent parts of the common anchor, as it is familiarly known, are the shank, the stock, the ring, or shackle, and the two curved arms, or crown, with their flukes. These parts were mostly of solid iron, except the stock, which was generally composed of two cheeks of wood, fastened together with hoops or tree-nails, and sometimes of metal. An English shipbuilder named Hawks secured a patent in 1823 for an improvement upon the then existing form, which consisted in forming a groove down the center of the shank, for the cable to pass through, and to which a chain was to be attached to the ring at the end.

Capt. Rodgers, of the Royal navy, devised a compound anchor in 1828, upon which he was granted a patent. It is inconceivable in these days that such a contrivance as is described could have received even passing consideration. It consisted of a hollow shank of iron, which was to receive a core of wood, and which, with the stock, was composed of several pieces bolted together.

The best anchors of the solid description were forged from "bundled" or scrap iron. For the introduction of an improved method in preparing the material credit was given to Henry Cort, the person who led the way to the practice of puddling in the conversion of cast into malleable iron. The forging of anchors by his method, or any other under the best circumstances, was a laborious business, even when a hammer of 800 or 900 pounds weight was employed.

With the general adoption of the solid iron or steel anchor as the most useful, there have not occurred many changes until the appearance some years ago of the stockless anchor with jointed arms, that is, joined to the shank by a hinge attachment allowing the arms to adjust themselves to the conditions as they were found at the bottom and to generally secure a firm hold.

The anchor of the present day is naturally a vastly different affair as to size from those in use seventy, or even twenty-five, years ago. The anchor now used on the largest battle ships has a maximum weight of about 17,000 pounds.

The object of the stock, which forms a cross with the shank and at right angles with the crown, is to compel the engagement of the flukes with the ground; obviously, with the fixed wooden stock an anchor of ordinary form is an awkward piece of equipment to "stow" on board, consequently the crown and shank were laid flat on a "bill board," leaving the stock in a vertical position over the bows of the ship. The adoption of the iron stock made it possible to arrange it so it could be slipped through the eye of the shank and the whole more conveniently stowed on board.

The commonest form of anchor, aside from the familiar conventional form with fixed stock, up to the advent of the now almost universal "stockless," was the Trotman. In this form the crown, with its flukes, was hinged or pivoted to the shank. This allowed of deeper penetration, the angle of movement being fixed by the point or "bill" of the upper fluke coming in contact with the shank. This anchor was almost invariably used on steamships until recent years.

With all these forms much time and labor were involved in "letting go" and in heaving up and getting on board. In narrow channels, and when getting inshore, the anchor was almost valueless unless previously got overboard and ready for instant letting go. It also occupied considerable valuable space on board and involved a lot of additional tackle and lashing.

The stockless anchor avoids all these difficulties. Its construction may be seen in almost any picture of a modern ship, from which it will be noted that the shank is pulled up into the "hawse-pipe" entirely within the hull, and only the flukes and crown are outside, lying snugly against the bow of the ship. With the steam windlasses now universally employed on modern sailing ships, the anchor is always ready for letting go; it is not even necessary to turn on steam. The anchor is held in place by a powerful brake on the windlass, and with the releasing or easing up of this brake the anchor shoots out of the hawse-pipe, running out the chain over the windlass.

For ships that lie at anchor continually, such as lightships, and must ride out the heaviest gales, swinging to every shift of wind or tide, the "mushroom" anchor is invariably employed, because no matter how the ship swings, it always retains its hold and does not break ground. Ordinary anchors suffer much from breakage under these conditions, and also as each time the anchor breaks ground it must drag, although it may be only a few feet, before it "trips" again, the ship may ultimately get considerably off her station. The advantages of the mushroom are thoroughly recognized, but as it has always been made with a rigid shank it is practically impossible to stow it, and it is therefore only employed under water.

The now common stockless anchor has some serious disadvantages. The hawse-pipe must be so much larger in order to house the shank that it leaves a large opening for the entrance of water when the ship is pitching. To avoid this, "bucklers" must be fitted as closely as may be about the chain at the inner end of the pipe, but they are never very tight, and they must be got clear before the anchor can be let go. Besides, the flukes and crown, projecting beyond the hull plating, form, from their shape, a savage weapon in case of two ships touching each other ever so lightly, as frequently happens in crowded harbors, and many collisions would have been comparatively harmless but for the projecting anchor nipping along the side of the other ship. The ship, herself, is sometimes damaged as a consequence of these anchors fouling wharves, etc.

The most recent development of the anchor, then, is to retain the stockless feature, with its convenience in handling and stowage, the holding power and anti-fouling qualities of the mushroom, and to present a smooth contour outside the ship, which will reduce damages from contact with wharves or other ships, and this has been done in an anchor in which the mushroom crown is made with a ball and socket connection to the shank, allowing it to assume any angle inferior to 70 degrees.

THE FASTEST SHIPS IN THE WORLD.

MERCHANT VESSELS

In a previous article on high-speed vessels we dealt solely with warships of the cruiser and destroyer types, and showed how, while length had increased in proportion to the speed, the attainment of very high relative speeds involved such an abnormal proportionate increase in space and weight occupied by the machinery that the fighting power was reduced to a minimum. (See Table III., page 57, February, 1908.)

We now propose to deal with fast mercantile vessels, and in their case the commercial necessity of profit-earning absolutely precludes the phenomenal speeds attained by warships. Armour and armament correspond largely to cargo and passenger-carrying capacity, and if the machinery is increased for a gain in speed, fighting power or dividends must obviously be sacrificed.

Retaining the basic standard of $\frac{V}{\sqrt{L}}$ as a measure of speed, and considering only the fastest merchant vessels in point of *absolute* speed, we must confine investigation to the three following classes of ships:

I. Channel steamers.
II. Mail steamers: (*a*) Atlantic traffic.
(*b*) Other services.
III. Intermediate vessels.

Channel steamers are in a class entirely by themselves, not only on account of the shortness of their voyages, but also on account of the fact that they are run in conjunction with or owned and supported by the principal railway companies and are run as an adjunct to these services, and not as independent profit-earning companies. Most of these lines make passenger carrying their chief consideration, and this, in addition to local considerations, of size of ports and dock dues, affects the design to a very marked extent. There are some twenty different lines or services running between England and Ireland, Scotland or the Continent; the shortest run is 21 and the longest 210 miles. In nearly all cases, except the Isle of Man service, the length of ship has hitherto been strictly limited—for the Newhaven and Dieppe vessels 280 feet is a maximum—and, as fierce competition stimulates the ever-increasing demand for speed, it has only been obtainable with the channel vessels owing to their not being dependent on cargo carrying. Absolute speeds have increased considerably in recent years, due largely to the general application of the steam turbine, and, with the exception of the large Cunarders, the fastest merchant vessels are found in this class of ship. Table I. shows the names and services, with the leading dimensions, of some of these vessels:

TABLE I.

Vessel.	Date.	Service.	Length, Feet.	Speed.	$\frac{V}{\sqrt{L}}$	I. H. P.	Displacement.
Manxman	1904	Heysham—Douglas	330	23.00	1.266	9,000	2,270
Londonderry	1904	Heysham—Belfast	330	22.29	1.228	7,200	2,150
Viking[1]	1905	Liverpool—Douglas	350	23.53	1.258	12,000	2,400
Princess Elizabeth[1]	1905	Ostend—Dover	344	24.06	1.295	11,000	2,000
Dieppe[1]	1905	Newhaven—Dieppe	280	21.6	1.29	6,500	1,360
St. George[2]	1906	Fishguard—Rosslare	350	23.00	1.23	11,000	2,500
Viper	1906	Ardrossan—Belfast	325	21.5	1.194	6,500	1,600
Empress[3]	1907	Dover—Calais	323	22.9	1.274	9,000	1,870
Connaught[2]	1896	Holyhead—Kingstown	360	23.5	1.24	9,000	2,180
Le Nord	1898	Dover—Calais	343	21.5	1.17	7,000	1,850
Anglia[2]	1900	Holyhead—Dublin	330	21.2	1.165	7,170	2,340
Arundel	1900	Newhaven—Dieppe	277	21.0	1.264	5,600	1,310
Alberta	1900	Southampton—Havre	270	19.9	1.212	5,350	1,530
Duke of Connaught	1902	Fleetwood—Belfast	315	20.1	1.13	5,800	2,210

[1]One sister ship of similar speed under construction. [2]Three sister ships also in service. [3]Four sister ships also in service.

The first eight are all turbine steamers, while the older six vessels in the second half of the table have reciprocating twin-screw engines, with the exception of *Le Nord,* which has paddles. The *Connaught,* built eleven years ago by Lairds, of Birkenhead, was always an exceptional vessel, and certainly one of the finest and fastest twin-screw channel steamers ever built. The rise in relative speed in recent years is clearly indicated by the increasing speed-length ratio, which places the *Princess Elizabeth, Viking* and *Empress* types distinctly above the *Amethyst* in Table III. (page 57, February, 1908). It is worth while remarking that none of these vessels would be possible with reciprocating engines. The light weight of their turbine machinery, together with the possibility of obtaining efficient propellers for such light drafts of water—only 9 feet 6 inches in the *Princess Elizabeth*—has rendered higher speeds possible on the same length of vessel—no light advantage for lines that exist on passenger traffic.

The case of large Atlantic liners is somewhat different. The conditions of ocean-going and of long voyages involve a proportionately heavier hull and greater regard for the coal bill; hence the reduction necessary in proportionate weight of machinery to displacement. Whereas it is found possible to put 3.5 to 5.5 horsepower per ton of displacement into a channel steamer, in fast Atlantic liners this figure is reduced to 1.8 in the *Mauretania,* 1.62 in the *Kaiser Wilhelm* II., and 1.52 in the *Deutschland,* while in the older vessels it is even less. In even the fastest vessels of the Atlantic intermediate type it has fallen to 0.6 in the *Carmania;* to under .5 in the *Baltic,* and to 0.4 in the *Saxonia.* The speed-length ratio of the fast liners has not risen much in recent years: since the *Campania* came out in 1893 the increase has been inappreciable, as the following table shows:

TABLE II.

Vessel.	Date.	Length.	Speed.	$\frac{V}{\sqrt{L}}$.	Horse-power.
Campania	1893	600′ 0″	22.0	0.9	30,000
St. Louis	1895	535′ 6″	21.08	0.91	21,000
Deutschland	1900	662′ 9″	23.5	0.913	36,000
Kaiser Wilhelm II.	1903	683′ 0″	23.5	0.9	42,000
Provence	1906	575′ 0″	22.0	0.917	30,000
Mauretania	1907	760′ 0″	25.5	0.925	70,000

Vessels of 16 and 17 knots speed are not now considered fast by the general public, but for long-distance services, such as from Madeira to the Cape of Good Hope, the enormous amount of coal that has to be carried becomes a serious item, and a speed of 17 knots is high for a distance exceeding 4,000 miles. Economic propulsion, therefore, becomes most essential, and a speed-length ratio of about 0.65 to 0.75 is more usual. Intermediate vessels of the *Saxonia* type on the North Atlantic approach the lower figure, while the *Baltic* class are even below it.

The question of what are the fastest vessels in the world can only be answered by introducing qualifying conditions. On a measured-mile trial or a short burst of a few hours' duration there is no doubt that the new oil fuel turbine-driven destroyers of the Royal Navy would give superior speed results to anything else, and even in fairly rough weather they would still prove far faster than the channel steamers. They are not designed for long-distance work; in fact, they cannot be, and it is one of the many penalties paid for high speed. Relatively to their length they are abnormally fast. But in really rough weather their low freeboard and short absolute length compared with the big liners would be a serious handicap, and it still remains unproved as to whether they could get away from the *Mauretania* and *Deutschland* in a heavy sea. Their light construction would make it a risky business to run them fast in really rough weather; certainly it was shown to be a very dangerous performance with the old 30 knotters of ten years ago.

The *Scout* class of cruiser—370 feet long and 25 knots—can only be called fast relatively to length. Not fast enough to catch destroyers except in rough weather, they are equally unable to get away from the *Mauretania* in smooth water, and in a very moderate sea their speed sinks below that of the German liners.

For war purposes, the gigantic new cruisers of the *Invincible* type will probably be found to be the fastest seagoing ships afloat. Their speed-length ratio is low compared even with the *Encounter* class, while their great absolute length and size will enable them to maintain their speed in weather in which it would be risky to drive even the *Tartar or Cossack.* The cruisers of this type come midway in point of speed-length ratio between the channel steamers and Atlantic liners.

What the future of high-speed ships will be it is hard to say. Already the new destroyers are beginning to provide unsuspected phenomena, and the speed of all types is rapidly increasing. That there will be a distinct increase in speed on a given length before long is quite certain; the reason will be the rapid improvement in the propelling machinery. The turbine has already done a great deal for the channel steamer, but it is rather to improve boiler performance that we must look for progress in the Atlantic liner. Oil fuel has given such remarkably good results in the British destroyers that its adoption for large vessels is only a question of time. There is little doubt that Yarrow type boilers and oil fuel in the large Cunarders would, in the same space and on the same weight, give about 20 to 25 percent more steam corresponding to an addition of between one and two knots to the speed. But would it pay commercially? Would the fuel be cheap enough and would the boilers be as durable? The profit-and-loss side of the question supplies the answer in all cases. Whether it be speed or fighting power for warships, dividends or speed in the merchant marine, the commercial conditions govern each case, and their diversity has supplied us with innumerable types from which to gather experience.

THE DEVELOPMENT AND PRESENT STATUS OF THE EXPERIMENTAL MODEL-TOWING BASIN.

BY H. A. EVERETT, S. B.

Establishment of the North German Lloyd Tank at Bremerhaven, Germany.

In 1899 the North German Lloyd Company had towed at Spezia the model for one of their projected express steamers, and the results obtained produced such a good impression that it was decided to construct an establishment of their own for similar work. This was completed in February, 1900, the tank being 540 feet long by 19.7 feet broad by 10.5 feet deep. The steel carriage which spans the tank is electrically driven by two motors. It weighs 11,000 pounds, and has a clear run of 475 feet, with a speed range of from 2 feet to 1,000 feet per minute. The models are of parafine, 15.5 feet in length, and the towing equipment for both hull and propellers is patterned after Froude's. This establishment is in very close connection with the German government, and has done some naval work for it besides, of course, that in connection with their own express steamers which belong to the Naval Reserve. Water from the River Weser supplies the tank after passing through filters.

The Berlin Tank.

The tank at Berlin, Fig. 16, is located in the "Thiergarten," or park, in Charlottenbourg, one of the outlying districts, and was commenced subsequent to an appropriation of 378,000 marks ($94,500) (£19,405) by the German government in 1901, and finished the following year. The control of the tank is rather peculiar, as it is used exclusively by the Navy Department for certain months of the year and by the Tech. Hochschule at other times. The tank itself is of concrete, 558 feet

maximum length by 34.5 feet breadth, and is 11.5 feet deep; there is a clear run of about 480 feet, but allowing for starting and stopping the carriage there is left about 250 feet to 260 feet for full-speed runs. The maximum speed of the carriage is about 1,400 feet per minute, and models up to 23 feet can be handled. The carriage has been constructed in two sections (see Fig. 15); the driving carriage and the instrument carriage, in order to minimize the effect of the wheel jar on the recording apparatus. The driving carriage is a large steel structure, 39 feet long, electrically driven by two motors, and has a span of nearly 20 feet. Inside the rectangle formed by the four wheels of the driving car (see Fig. 16) is the smaller rectangle formed by the wheels of the instrument car, which is coupled directly to the former, and which travels on the same tracks. The track on which the cars travel is supported on pillars at intervals of about 6 feet, and considerable discussion has arisen concerning the effect of these local rigid spots in the track upon the recording apparatus. Those in charge of the tank state that no trouble is experienced, and that the matter was thoroughly tested out in the tank at Bremerhaven with a similar arrangement. The

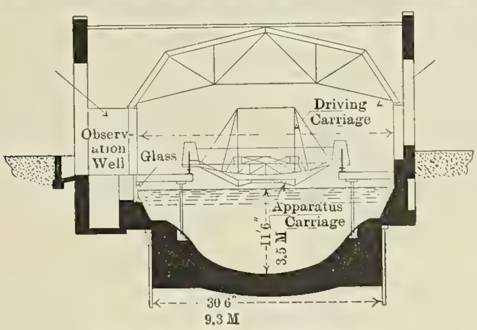


FIG. 15.—SECTION THROUGH C-D.

section of the tank is somewhat similar to that at Washington (see Fig. 15), with sloping sides and submerged ledges at the top, but it has provision for building in a smaller temporary section, so that the influence of depth and various canal cross-sections may be studied, this last being of especial interest in Germany. The resistance and propeller mechanisms are of the general type of Froude's, as already described. It was originally intended to obtain the water for the tank (3,700 cubic meters) from the nearby canal, but later it was decided it would be better to take from artesian wells, which has been done. Paraffine is the material used for models, and gas is used for melting it. The head end of the tank building is directly under the Berlin Elevated Street Railway, and it is reported that the vibrations from passing trains sometimes prove troublesome. Half-way down the length of the tank a glass plate, nearly 50 feet long, is fitted in the side, to investigate and photograph the wave-formation of the passing model. The propeller mechanism is designed for one, two or three shafts, and will take single or multiple screws on each shaft; it is, moreover, capable of testing them at any desired revolutions up to 3,000 per minute, this wide range being thought desirable for investigating turbine propellers. In line with this is the propeller-measuring apparatus, which permits of measuring the model propellers to 1/20th of a millimeter. The nominal head is Prof. Oswald Flamm.

The Tank at the Clydebank Shipyard of John Brown and Company, near Glasgow

This is the most recent tank (Fig. 17 and Plate II.), and the second privately constructed in Great Britain. It is 445 feet long by 20 feet broad by 9 feet deep, and has 400 feet available for towing. It is of concrete, rectangular in section, with the docks and trimming tanks at one end and a sloping beach, 25 feet long, to assist in breaking up the waves at the other end. The building is of brick, and contains

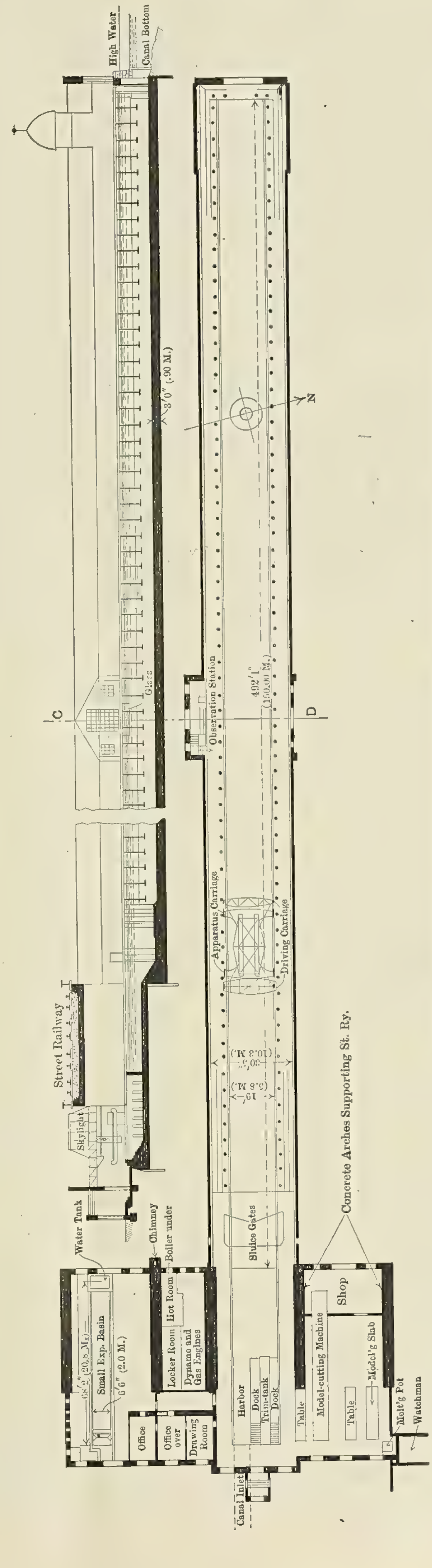


FIG. 16.—PLAN AND ELEVATION OF THE EXPERIMENTAL MODEL TOWING BASIN AT CHARLOTTENBURG.

the drafting, tracing and record rooms and the superintendent's office, and in an adjoining building is the model-making department. The models are of paraffine, with a standard length of 15 feet, though this is sometimes departed from. The building is heated in winter by hot water. The fairing up lines to large scale, to eliminate the error caused by the shrinkage and expansion of paper with varying atmospheric humidity. The tanks for melting the paraffine, together with the casting box and the cutting machine, are in the hall at the head, or north end, of the tank. For experimental work

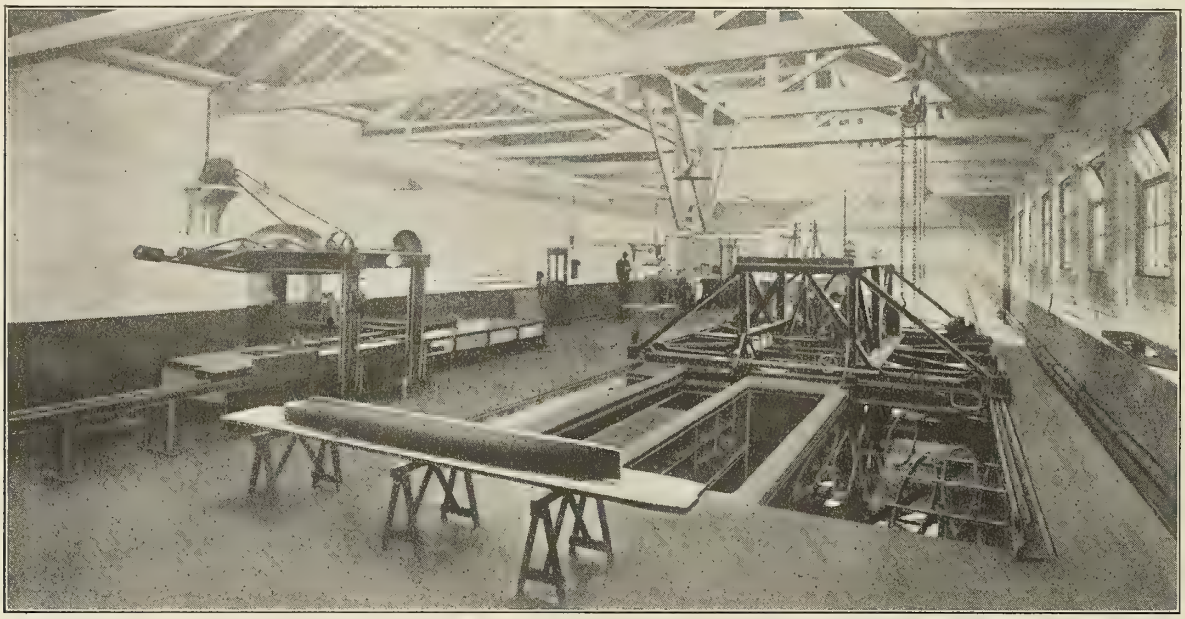


FIG. 17.—INTERIOR OF THE TANK AT THE CLYDEBANK YARD OF JOHN BROWN & CO.

towing carriage is a light, wooden trussed structure (see Fig. 17), reinforced by metal, which spans the tank, and weighs, exclusive of propeller mechanism, 2 tons. It is electrically driven (the only one so driven in Great Britain) by two 6-horsepower motors, and has a speed range up to 1,000 feet per minute. The resistance and propeller mechanisms are after Froude's pattern (see Fig. 3). In the drawing office a large marble slab (20 feet by 4 feet 6 inches) is used for

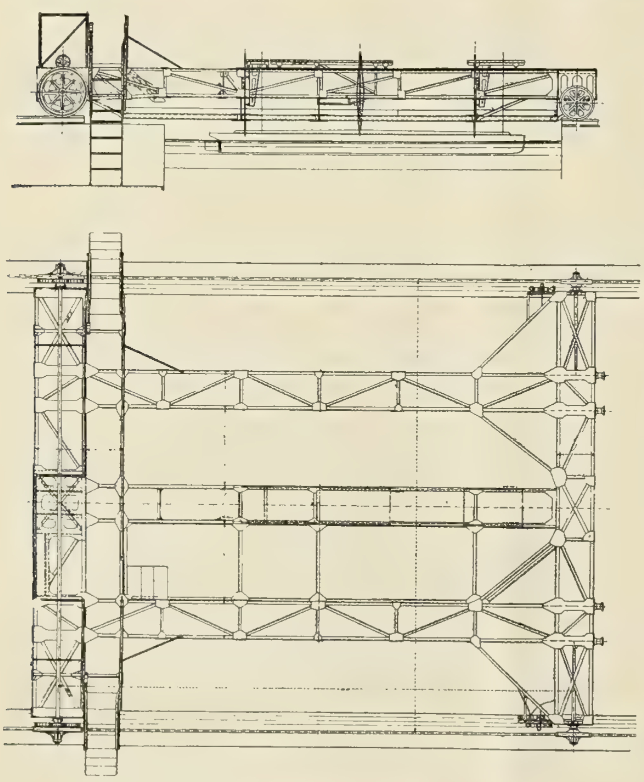


FIG. 18.—TOWING CARRIAGE AT THE UEBIGAU TANK, DRESDEN.

the following force is employed: Draftsmen, 6; experimenters, 3; mechanics, etc., 4; giving a total of 13 men. The tank was completed November, 1903, and is in charge of Mr. W. J. Luke.

The New "Uebigau" Tank near Dresden, Germany.

As the new tank at Uebigau, near Dresden, the newest of the three German tanks, is the direct outgrowth of the old Uebigau tank, we will describe the two together. The first one was built by the Elbe Steamship Company "Kette" in 1891-2, and was established primarily to obtain information for the design of river steamers. Although not completed until this date it had been originally projected as far back as 1883, and the carriage and measuring instruments completed the following year. The tank itself, however, languished until the company obtained the contract for two swift steamers to be fitted with Zeuner's turbine propellers, and this furnished the incentive which resulted in the completion of the tank in 1892. It was built of brick, and was 206 feet long by 24.6 feet broad by 4.5 feet deep, with sloping sides and a flat bottom (see Plate I.). The carriage was a small affair of less than 2 feet span, drawn by a man, and provided with a pull dynamometer and a speed and time device. Later electricity was tried for motive power, but was discarded on account of its non-uniformity of speed. The tank was not roofed over, and for eight years was the only one of any sort in Germany, and served both navy and merchant marine. Soon after its completion, on the suggestion of the government, it was lengthened to 394 feet, roofed over and the tracks suspended from the roof. After that the government paid a yearly indemnity and received in return extensive use of the tank, and it served also as an experimental laboratory for the Dresden Tech. Hochschule.

Agitation for a new tank was kept up for some time, and finally resulted in a grant from the Saxon government, with the provision that the new establishment should be used by the Tech. Hochschule at Dresden as an experimental station and laboratory similar to the arrangement at Berlin with the Tech.

Hochschule at Charlottenburg. The new tank was begun 1903 and ready for work in 1904 (Plates I. and II.); it is 312 feet long by 21.0 feet broad on the water surface by 11.3 feet deep, of concrete, as shown in the cut, and embodies some innovations, notably the towing dynamometer. The water is furnished from a spring, pumped in by a pulsometer, and the tank empties directly into the River Elbe. The tank is provided with supports, as in the case of the Berlin tank, to permit of false sides and bottom being built in for investigation of the effect of depth and various canal cross sections on the resistance.

Half-way down the length of the tank is the observation and photographic station for wave profile and similar work. There is a large plate-glass window inserted in the side of the tank and a tunnel which goes completely under it. This latter is provided with round plate-glass windows, similar to ships' deadlights, in its roof, so that the model can be observed or photographed from any position above or below as it is towed by.

The carriage (Fig. 18) is of steel-latticed girders, three fore and aft and two across, and has a length of 29.6 feet and a span of 23 feet. It is of 5½ tons weight, electrically driven, and has a speed of from about 10 feet to 1,000 feet per minute. It has the unique feature of being controlled from a stationary platform at one end of the hall. The towing mechanism is somewhat different from those already described, as will be seen from the diagrammatic sketch (Fig. 19). *"M"* is a small electric motor, that keeps such a tension in the dynamometer spring *I* that the vertical towing rod *A* is maintained clear of

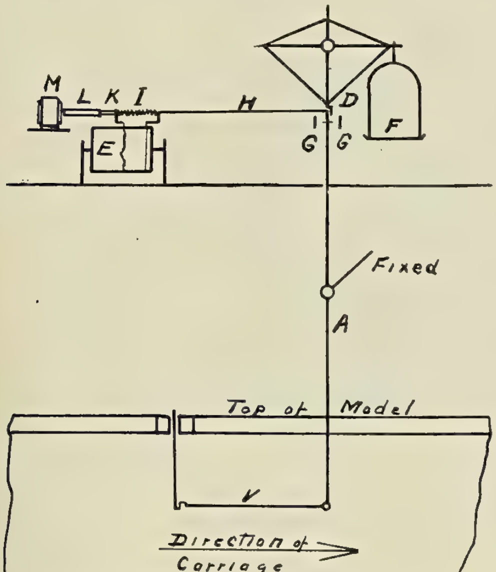


FIG. 19.—DIAGRAM OF APPARATUS FOR RECORDING MODEL RESISTANCE AT UEBIGAU.

the two contact points *G G*, when the pull of the model is shown by the distortion of the spring plus the weights in the scale pan *F*. The contacts *G G*, which govern the tension in the spring by the motor, are only a very minute distance apart (1 mm.), only enough to keep the current from leaping across, and so the system is in equilibrium practically all the time. The propeller mechanism also follows the same ingenious line (see Fig. 20) in the part for recording thrust. The propeller is carried by the frame *ABCD*, which is free to swing in a fore and aft direction, and is driven by shafting, with universal joints and bevel gears passing through the frame. The operator knows approximately what the thrust is going to be, and places weights in the scale pan *F* to take it nearly up, the rest is taken up by the motor regulated spring *S*, as in the case of the towing mechanism above. When the lever *JEL* is pulled out of its vertical position it strikes one of the contacts *G*, which starts the motor *M*; this, by means of the screw and sleeve *K*, extends or compresses the spring *S*, until the lever *JEL* is drawn back to its vertical position when the system is in equilibrium, and the thrust is shown by the sum of the weights in the scale pan plus the distortion of the spring *S*. As the contacts *GG* are a very minute distance apart the movement of the lever, and consequently the pen *O* is very slight, and the line traced by *O* is practically a straight one. For the turning moment a torsion dynamometer is inserted in the driving shaft, as indicated in the cut. The propeller

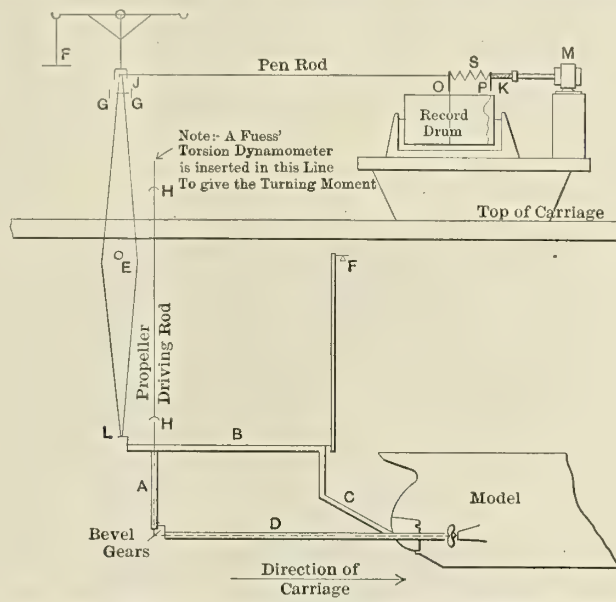


FIG. 20.—DIAGRAM OF APPARATUS FOR RECORDING PROPELLER THRUST, TURNING MOMENT, ETC., AT UEBIGAU.

apparatus, as above described, is arranged so that four shafts can be run at once. This tank also has a wave-measuring apparatus of recent design.

Tank of the French Admiralty at Paris.

This tank, on the banks of the Seine River, in Paris, was opened in July, 1906, and is 523 feet long by 32.8 feet wide by 13.1 feet deep at water level, with a length of tow of about 442 feet. It is the only establishment of its sort in France, though at Brest for the past thirty years model-towing experiments have been carried out in a less satisfactory way, as already described. Paraffine is the model material here as in other European establishments, but Paris has rather high temperatures at times, and it is rumored that paraffine has given some trouble. There is a slight departure from customary practice in the casting of the model, in that an outer carene of wooden lathes, covered inside with canvas and painted, constitutes the mold instead of the tank of clay with the carene hollowed out of it. The core is made and suspended in the usual way, and the rest of the process follows the regular lines. The tank is approximately semi-circular in section, of concrete, and is supplied with water from the city pipes. The carriage is a large steel-trussed structure, weighing 25 tons (French) and driven by four electric motors, one at each corner. It has a speed range up to nearly 1,200 feet per minute, which for a model one-sixteenth size corresponds to about 48 knots. The carriage is about 40 feet long by 35 feet broad, and is equipped with both hull and propeller mechanism, the latter, perhaps, a trifle more complicated than some tanks, as the French government frequently uses triple screws on warships. The staff numbers three electricians, one modeler, one draftsman, and an experimental force of three. The total cost of the establishment was 625,000 francs, or $125,000 (£25,667), and was divided as follows: Tank, 360,000 francs ($72,000) (£14,784); apparatus, 265,000 francs ($53,000) (£10,883).

The Tank at the University of Michigan, Ann Harbor, Mich.

This tank (Figs 21 and 22), which was finished in 1906, is located in the basement of one of the engineering buildings of the above-named university. It is 300 feet long by 22 feet wide, with a depth of water of 10 feet, and also serves as a reservoir for the adjoining hydraulic laboratories. It has an arched bottom with straight sides, which also serve as the foundation for the engineering building. Along each side is a concrete bracket for carrying the tracks of the towing carriage which spans the tank. At the scuth erd are the docks and the filters through which the tank is filled. The carriage is electrically driven (one motor), and has a speed range of from 15 feet to 800 feet per minute. The resistance mechanism is not radically different from the Froude type, and no propeller apparatus is as yet installed, though it is intended to have one. The models are of paraffine, and range from 10 to 12 feet in length. The summer temperature here is apt to be rather higher than the 75 degrees F. that is customarily believed to be the limit for parafine to satisfactorily retain its form, but it was adopted primarily on account of its cheapness. The tank is in charge of Prof. H. C. Sadler.

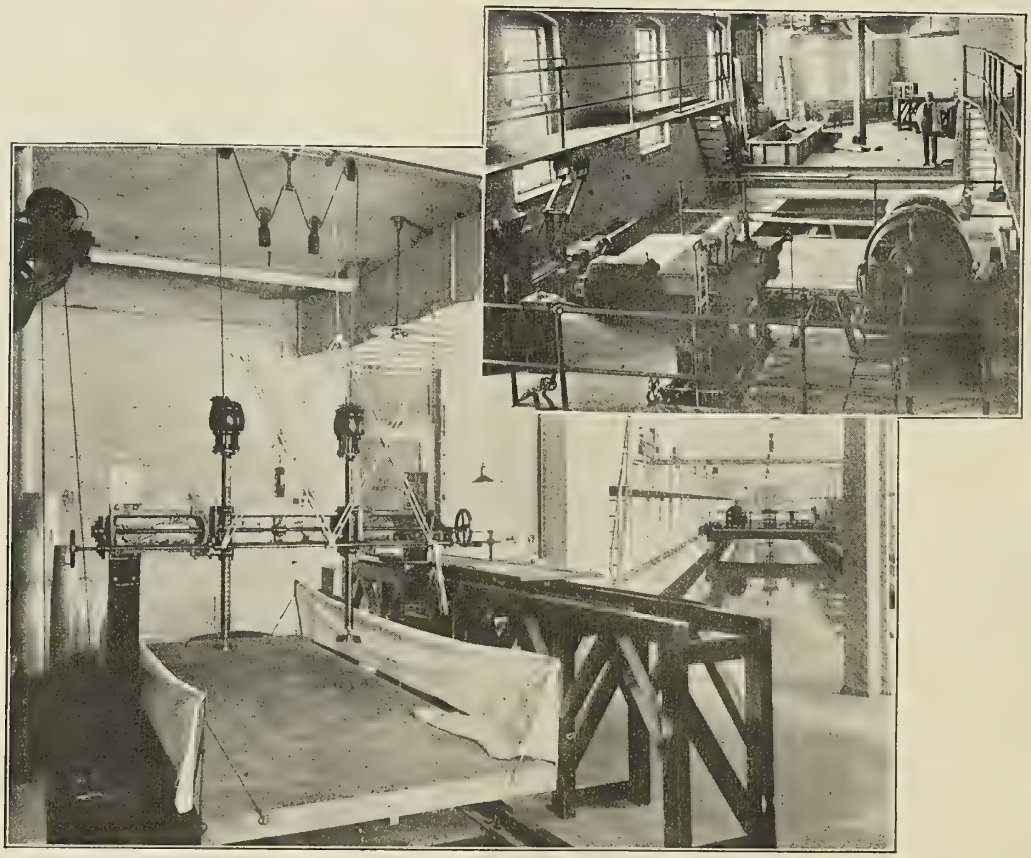


Fig. 21.—Model Cutting Apparatus. Fig. 22.—The Tank and Carriage.

VIEWS OF THE MODEL TOWING BASIN AT THE UNIVERSITY OF MICHIGAN.

There is in addition to the above-named tanks one practically completed at the shipyard of the Mitsubishi Shipbuilding Company, Nagasaki, Japan. The dimensions of this tank are as follows: Length, 430 feet; depth, 12 feet; width, 20 feet. Twelve-foot models of paraffine are used, and the towing carriage is electrically driven. Complete details of this tank have not been made public, but as it is being installed by Kelso & Company, of Glasgow, under the direct supervision of Mr. John Denny, of the firm of William Denny & Brothers, it is safe to assume that it follows the general design of existing British tanks.

In 1904 it was proposed to establish a tank at Bushy, that should be in the nature of a commercial establishment, available to all firms, and it was also to be devoted to the solution of problems of general scientific interest, the results of which were to be freely published. It was criticised in its first aim by those in connection with the existing tanks, on the ground that it would be entirely insufficient, as each owner of any of the present tanks had more than enough work to keep his tank busy all the time. For the second part of the proposition (purely scientific investigation) it was universally considered desirable, but the necessary funds were not forthcoming, and no further steps have been taken.

That the financial gain to a company through increased efficiency by the control of a tank more than returns the interest on the invested capital is evidenced by the fact that no tank has ever been discontinued, and also that several more are projected by private firms. As for the government establishments, the simple statement that tanks are possessed by the six greatest powers is ample proof of the universal belief in William Froude's methods as applied in the modern Experimental Model Basin.

The towing of models by means of a traveling bridge spanning the tank, as in all the foregoing establishments, has several undesirable features for extremely accurate work. First, the speed is never absolutely constant, owing to minute mechanical irregularities of the wheels, tracks and driving motors; second, a large amount of time and power is wasted in bringing the apparatus to speed and in stopping it, as the model is, as a rule, only a small proportion of the total moving weight; third, the high cost of construction and maintenance. There have been several attempts to eliminate or modify these, and recently a scheme, by Mr. H. Wellenkamp, has been attracting considerable attention, especially in Germany, where two tanks are to be built for using his method, one for the Hamburg government and one for the German navy. Briefly,

his method consists in towing models by stationary apparatus on shore and using weights for the towing power, as Beaufoy did, so utilizing the absolutely uniform force of gravity. The acceleration to the desired speed is obtained by a large weight, which is automatically disconnected when the model reaches its speed, and the towing is then continued by a small weight, which continues the towing at uniform speed, and which is the measure of the resistance. The use of the large weight for accelerating quickly to the desired speed permits of the shortening of the tank very materially, and the use of the absolutely uniform force of gravity for the towing force contributes to the same end, as the record, being constant, need be taken only for a very short distance. Mr. Wellenkamp states that the length of the tank should be four and one-half times the length of the longest model to be tested (1½ for the acceleration, 1½ for the run, and 1½ for the stopping), and claims that the cost of construction and maintenance is far less than a basin of Froude's type.

SCOTCH SHIPBUILDING IN 1908.

BY BENJAMIN TAYLOR.

When a year ago we reviewed the shipbuilding of 1907, we said it was not a record year and it did not exceed the preceding year *except in Scotland,* which thus stood foremost in all the shipbuilding centers of the world. But in 1908, even in Scotland, we have but a sorry record. It was a bad year in shipbuilding, as in everything else. Taking once more the statistics of the *Glasgow Herald* (which I know personally to be as accurate as may be) we have the British total of 1,325 vessels of 1,076,562 tons and 1,148,375 indicated horsepower—a decrease from 1907 of 751,733 tons and 627,330 indicated horsepower. The output was divided as follows over the three kingdoms:

	1908.			1907.		
	Ships.	Tons.	I. H. P.	Ships.	Tons.	I. H. P.
Scotland...	680	400,194	528,702	757	675,173	742,289
England...	623	517,752	514,183	1,031	1,014,670	951,176
Ireland....	22	158,616	105,490	38	138,452	82,230
Totals...	1,325	1,076,562	1,148,375	1,826	1,828,295	1,775,705

From the British colonies the returns so far show 167 vessels of 30,451 tons and 11,722 indicated horsepower, as against 189 vessels of 36,344 tons and 14,923 indicated horsepower in 1907; and our foreign returns so far show 1,384 vessels of 1,161,750 tons and 986,062 indicated horsepower in 1908, as against 1,480 vessels, 1,442,958 tons and 1,355,223 indicated horsepower in 1907. This makes a world total in 1908 of 2,876 vessels of 2,268,763 tons and 2,146,159 indicated horsepower, against 3,495 vessels of 3,301,597 tons and 3,145,851 indicated horsepower in 1907; a decrease in round numbers of 1,030,000 tons, which closely approximates the amount of British tonnage now lying idle in the ports waiting for remunerative charters.

Turning attention now specially to Scotland we find a marked contrast with 1907, when there was a large increase in the number of vessels launched, owing to the special demand of the year for small fishery steamers. The number of vessels in 1908, however, was still large in proportion to the total tonnage, by reason of the number of barges constructed and of small vessels for employment in foreign countries taken to pieces and shipped abroad as cargo, this last especially in Scotland.

The total production of the Scotch shipbuilding yards and engineering shops in 1908 consisted of 680 vessels of 400,194 tons and engines of 528,702 indicated horsepower. In 1907 the total was 757 vessels, 675,173 tons, and 742,299 indicated horsepower, so that there has been a reduction of 77 vessels, 274,979 tons and 213,597 indicated horsepower. Most of this tonnage decrease was on the Clyde, but the Forth has fallen from 58 vessels of 21,370 tons and 28,342 indicated horsepower to 25 vessels of 11,143 tons and 14,262 indicated horsepower, and the Dee from 134 vessels of 16,212 tons and 20,035 indicated horsepower to 61 vessels of 7,601 tons and 13,640 indicated horsepower. The Tay alone of the East of Scotland districts shows a small increase. The East of Scotland has not been affected so seriously by bad trade as the West, and Dundee had a fair amount of work all through the year.

The following was the output of the Clyde builders:

	Sail.		Steam.		Total Tons.	1907. Tons.
	Ships.	Tons.	Ships.	Tons.		
Russell & Company.......	...	....	13	48,619	48,619	71,705
Barclay, Curle & Co........	...	....	6	38,810	38,810	47,332
Charles Connell & Co.....	...	....	7	30,698	30,698	40,298
Wm. Denny & Bros.......	...	....	15	20,875	20,875	34,418
Alex. Stephens & Sons.....	...	....	4	19,904	19,904	44,094
D. & W. Henderson & Co..	2	234	4	17,571	17,805	35,886
The Fairfield Company.....	...	....	3	17,520	17,520	48,020
Caird & Company..........	...	....	2	16,723	16,723	6,437
Napier & Miller..........	...	....	4	16,211	16,211	19,785
John Brown & Co........	...	....	3	15,300	15,300	35,293
Wm. Beardmore & Co.....	..	....	1	11,533	11,533	14,500
Wm. Hamilton & Co......	...	....	2	11,386	11,386	41,305
A. MacMillan & Son.......	...	....	5	9,715	9,715	21,918
Wm. Simons & Co.	22	1,990	9	5,943	7,933	4,773
Clyde Shipbuilding Co......	...	....	4	7,201	7,201	10,981
A. & J. Inglis.............	...	....	5	6,777	6,777	3,503
Lobnitz & Co.............	3	180	20	6,483	6,663	5,772
Green'k & Grangem'h Co...	...	....	3	6,524	6,524	16,337
Ailsa Shipbuilding Co.......	16	1,200	6	4,695	5,985	10,778
Fleming & Ferguson........	2	1,200	8	3,850	5,050	6,153
Mechan & Sons...........	183	4,085	1	120	4,205	3,011
Scott's Shipbuilding Co......	...	....	2	4,171	4,171	20,916
Ferguson Bros............	...	....	9	3,086	3,086	4,500
Alley & MacLellan.........	19	2,190	6	740	2,930	2,704
Yarrow & Co.............	...	....	13	2,813	2,813	.....
Bow, McLachlan & Co......	20	1,800	4	561	2,370	3,217
D. J. Dunlop & Co.........	.....	....	1	2,308	2,308	2,000
Mackie & Thomson........	...	....	17	2,157	2,157	3,663
A. Rodger & Co...........	...	....	2	1,801	1,801	22,674
John Fullerton & Co.......	...	....	5	1,883	1,883	3,011
Scott & Sons..............	...	....	11	1,629	1,629	2,436
Ardrossan S. B. Co.........	7	140	7	1,377	1,517	873
George Brown & Co........	...	....	3	978	978	3,186
John Reid & Co...........	...	....	2	412	412	71
Ritchie, Graham & Milne...	6	310	3	67	377	1,885
P. Macgregor & Sons.......	1	25	7	289	314	481
William Fife & Son........	6	297	...	....	297	297
Murdoch & Murray........	...	....	1	282	282	6,850
J. & J. Hay...............	...	....	1	92	92	70
Other Firms..............	31	369	32	273	642	15,786
	318	14,119	251	341,467	355,586	619,919

The production of Clyde shipyards has fallen to the level of 1894. The tonnage increased steadily from 1904, rising each year by about the same amount, until at the end of 1907 the Clyde produced almost 620,000 tons. The anticipations of a decline in work in this district were realized in 1908, very soon after the year began. The labor troubles on the Northeast coat of England diverted a few contracts to the Clyde, but they were not sufficient to rally the industry generally. The Northeast coast and the Clyde are so closely bound together by organizations of employers and of men that the slightest trouble in one place immediately affects the other. When, therefore, the employers and men on the Tyne, Wear and Tees came to loggerheads, builders on the Clyde were chary of fixing dates for the delivery of vessels, and the placing of contracts was deferred until the industrial atmosphere cleared. It did clear up, but the trade situation became worse, and shipowners would only order new vessels at extremely low prices. The work under construction steadily dwindled. At the end of the year the output was 569 vessels of 355,586 tons, as compared with 526 vesels of 619,919 tons in 1907. The number of vessels is larger, but this is accounted for as above. Of ordinary cargo and passenger vessels a much smaller number than usual were launched, and there were less than half a dozen first class passenger liners. Large warships, too, are conspicuous by their absence from the year's list of launches. There were only a few destroyers to place against the battleships of 1907.

With such a large reduction in the shipyards it was inevitable that there should be a decrease in the production of the

Glasgow marine engineering shops. These depend almost wholly on Clyde yards for their contracts. The year's work represents a total of 474,400 indicated horsepower, as compared with 668,527 in 1907—a reduction of 194,127. There was less demand for machinery generally, and less work for the shops in which engines of standard types are constructed, and there were few large or highly-powered vessels built on the river.

In 1907 the Fairfield Company had the largest output of machinery on the river—112,000 indicated horsepower. In 1908, Denny & Company head the list with 57,100, while David Rowan & Company are second with 43,890.

The following is a summary of the Clyde marine engineering returns:

	1908, I. H. P.	1907, I. H. P.
Denny & Co	57,109	63,200
David Rowan & Co	43,890	50,220
John Brown & Co	41,750	73,000
Yarrow & Co	32,830	.....
Barclay, Curle & Co	33,150	40,532
Caird & Co	23,500	7,700
Alex. Stephens & Sons	20,660	35,930
The Fairfield Co	20,460	112,009
William Simons & Co	18,910	7,345
Dunsmuir & Jackson	18,000	26,250
D. &.W Henderson & Co	16,650	30,300
W. V. V. Lidgerwood	14,150	16,540
Ross & Duncan	12,940	10,735
John G. Kincaid & Co	12,850	22,750
Wm. Beardmore & Co	10,000	11,000
A. & J. Inglis	9,800	3,509
Fleming & Ferguson	9,450	9,100
Bow, McLachlan & Co	9,310	4,220
Lobnitz & Co	8,970	9,760
McKie & Baxter	6,920	9,710
Clyde Shipbuilding Co	6,880	12,600
Ferguson Bros	6,750	7,709
Ailsa Shipbuilding Co	5,620	8,000
Muir & Houston	5,000	10,470
Hutson & Sons	4,960	4,650
Scotts' Shipbuilding Co	4,000	11,700
Rankin & Blackmore	2,700	29,250
Campbell & Calderwood	2,580	3,620
Gauldie, Gillespie & Co	2,450	2,700
A. Rodger & Co	1,900	13,775
James Ritchie	1,850	1,500
David J. Dunlop & Co	1,800	2,000
Aitchison, Blair & Co	1,700	4,380
Renfrew Bros. & Co	1,300	2,600
Fishers (Limited)	1,120	1,350
Colin, Houston & Co	1,060	2,890
Allan, Anderson & Co	660	1,415
J. & R. Houston	600	365
White & Hemphill	450	940
J. & J. Hay	100	70
Other Firms	.....	5,700
Totals	474,400	668,527

The following table shows the output of English shipbuilding districts for 1908 in comparison with 1907:

	1908.		1907.	
	Ships.	Tons.	Ships.	Tons.
Tyne	115	210,110	148	336,922
Tees & Hartlepool	38	96,061	83	240,268
Wear	40	85,351	90	295,432
Royal Dockyards	5	43,060	3	51,800
N. W. Coast	95	39,232	117	20,645
Humber	98	21,714	135	36,659
English Channel	106	10,237	124	9,499
Thames	112	9,881	270	15,420
Bristol Channel	14	2,106	61	8,025
Totals	628	517,752	1,031	1,014,670

The depression was felt much earlier in the North of England than on the Clyde. On the Tyne, Wear and Tees there were decreases even in 1907, but they were small in comparison with those of 1908. The low tonnage is accounted for partly by bad trade, but also by the labor disputes of the early part of the year. In engineering, the North-Eastern Marine Company's Wallsend shop leads for the river with 44,240 indicated horsepower, a reduction of about 22,000 indicated horsepower as compared with last year. The Wallsend Slipway Company's decrease is more pronounced, but in 1907 they had the turbines for H. M. S. *Superb,* which represented 22,500 indicated horsepower. All over, the engineering of the district is only about half what it was in 1907.

In the last few weeks of 1908 there were slightly better prospects on the Northeast coast. A number of orders were placed, but there was great disappointment on the Tyne that only a very small proportion of the recent Admiralty contracts for British cruisers and destroyers has gone to the district. Builders there depend almost wholly on cargo steamers, and they will not be again busy until there is more work for that type of vessel.

The Belfast shipyards all through 1908 were busy, and they have a total of 16 vessels of 156,831 tons, as compared with 32 vessels of 137,360 tons in 1907. Harland & Wolff launched eight ships of 106,528 tons and 65,840 indicated horsepower, and the outlook there for 1909 is favorable, with orders on hand for the two big White Star liners, and vessels for the Bibby, Royal Mail, Australia United, Leyland and other lines.

There is hope that during 1909 the shipbuilding and marine engineering trades of the Clyde will experience a revival, although there is nothing in the present situation to justify the belief. The slight fluctuations of the freight markets and the scrapping of unemployed cargo vessels, have affected the shipyards very little, and but for the recent placing of warship orders the district would have been no busier than it was at the depth of the depression. There has not been any real improvement outside the yards affected by the naval work. Only one yard on the river—Yarrow's—is fully occupied, and in many cases there is only sufficient work to keep the gates open. There has never been a time when the "tramp"-building firms had so few contracts or when there was such keen competition.

Even in the three yards which have obtained naval contracts short time is the rule. The naval vessels consist of one cruiser of 4,500 tons displacement for each of the Fairfield, Clydebank (Brown) and Dalmuir (Beardmore) yards; three destroyers for Fairfield, three for Clydebank, one for the London & Glasgow Shipbuilding Company, Govan, and one for Denny & Company, Dumbarton.

Besides naval work, the Fairfield Company are completing the Orient liner *Otway,* and are building three steamers, each of about 2,000 tons, for the Zealand Steamship Company—a total of about 16,800 tons. The London & Glasgow Shipbuilding Company have an Orient liner on the stocks ready for launching. Mackie & Thomson have three small steamers, aggregating 1,100 tons, for Colonial owners; Alex. Stephen & Sons, Linthouse, two steamers of 11,670 tons; A. & J. Inglis, Pointhouse, a train-ferry steamer of 1,700 tons for South America; D. & W. Henderson & Company, Partick, a small steamer for Aberdeen, and another for Glasgow; Barclay Curle & Company, a steamer of 3,900 tons for foreign owners; John Reid & Company, one steamer of 150 tons; Ritchie, Graham & Milne, two 20-ton barges, and Charles Connell & Company, two steamers of 7,000 tons. At Scotstoun, Yarrow & Company have their new yard full up with Brazilian destroyers and light craft of various types for foreign countries. At Clydebank, John Brown & Company have a paddle steamer for London owners, and at Renfrew there are two dredgers building in Lobnitz & Company's yard, and one in that of Simons & Company. At Old Kilpatrick, Napier & Miller have several cargo steamers, and at Bowling, Scott & Sons have three steamers of about 500 tons. At Dumbarton, Denny & Company are completing the fastest vessel they have yet built—a 33-knot British destroyer—and they have also a large steamer for the New Zealand Shipping Company, another for P. Henderson & Company's Rangoon service, and two vessels for Irish Channel Railway service—altogether about 20,000 tons. McMillan & Son have a large steamer for an Italian firm, and two for other owners—a total of about 15,000 tons. The prospects in Dumbarton are therefore good. At Paisley, Fleming & Ferguson have four vessels, representing about

3,200 tons; Bow, McLachlan & Company, two of 800 tons, and John Fullerton & Company orders for several small vessels. But although there is a fair amount of work in Greenock yards, the outlook there is not promising. None of the new Admiralty orders went to that district. The contracts on hand make an aggregate of about 45,000 tons. Caird & Company are completing the P. & O. steamer *Malwa,* and they have the sister ship *Mantua* on their stocks almost ready for launching. Scott's Shipbuilding Company have orders for two first-class steamers, each of 7,500 tons. The Greenock & Grangemouth Shipbuilding Company are building two large oil-tank steamers, each of a carrying capacity of over 6,000 tons, and a steamer, 265 feet in length, for the Eastern trade; and George Brown & Company, a coasting steamer of 200 tons. At Port Glasgow, Murdoch & Murray, and D. J. Dunlop & Company have nothing on hand, but the other firms are fairly well supplied for the next half year. A. Rodger & Company have a steamer of 7,500 tons for Glasgow owners, and a steamer of 5,500 tons for Furness, Withy & Company; the Clyde Shipbuilding Company have three vessels, each about 300 feet in length; Ferguson Bros., a large dredger for Buenos Ayres; Robert Duncan & Company, a steamer of 8,000 tons and one of smaller dimensions; Russell & Company, four passenger and cargo steamers, two river steamers and a number of barges; and William Hamilton & Company, a large floating dock for foreign owners and two other vessels of about 7,000 tons each; the Ailsa Shipbuilding Company are building, at Troon, three steamers of 4,790 tons, and at Ayr one of 425 tons; and the Campbeltown Company, two steamers of about 2,600 tons each. There is no new work at the Ardrossan yard.

The work under construction on the River Clyde is about 307,000 tons, as compared with 315,000 at the end of 1907. Govan, Partick and Scotstoun yards have about 100,700 tons; Clydebank, Dalmuir & Renfrew, 25,000; Dumbarton, Bowling and Old Kilpatrick, 43,500; Paisley, 6,000; Port Glasgow, 77,000; Greenock, 45,000; Firth of Clyde yards, 9,000, and other small yards 800 tons.

At the close of our review a year ago we stated that the reversing turbine had not yet been developed, and that the internal combustion engine might displace not only oil fuel and boilers, but also both turbines and reciprocating engines. The oil-motor has come into practical use on board two vessels of the well-known MacBrayne line, employed in the West Highland trade. The reversing turbine has still to come, but meanwhile we have a compromise. Denny & Company, of Dumbarton, were the first to apply the turbine to the propulsion of merchant steamers, and they were the first to demonstrate the practicability for low-speed vessels of retaining the old engines as an auxiliary to the turbine. The New Zealand steamer *Otaki* has proved more economical of steam than her sister ships. When Harland & Wolff have completed the *Laurentic* for the White Star Line's new Canadian service, the combination system will be tested on a larger scale, but there is already no doubt of its success as a compromise.

Engineers are still waiting for the reversing turbine and the adaptation of the fast-running turbine to the slow-moving propeller. But Mr. Mavor, at Glasgow, and Mr. W. P. Durtnall, at London, have each submitted proposals introducing electric control between the turbine and the propeller. Nothing has yet been done in the way of practical experiment, but if successful it will be a more revolutionary development than the combination of turbines and reciprocating engines, although it will leave untouched the great question of motive power. It will not abolish the steam generator, like the oil or gas engine. MacBrayne's two oil-propelled vessels are running satisfactorily, and the Royal Naval Reserve gunboat Rattler has proved that gas engines may be used for a vessel of large size. There is not sufficient evidence yet to justify still larger ships having machinery of similar types, and at present the most promising line of development is that of electric control between the turbine and the propeller.

The cost of building new merchant steamers is roughly estimated to have declined 10 percent during the year. The actual decline is probably more, as builders are disposed to anticipate a further decline in material, if not in labor. But as second-hand vessels only a few years old have been purchasable at a decrease of 25 percent, and older vessels at a still greater depreciation, there is not much inducement to order new vessels of the ordinary tramp type, especially in the present state of the freight markets.

PROPELLERS.

BY W. G. WINTERBURN.

In a recent issue of this journal I noticed that among the propeller patents our old friend, the continuous paddle, had once again been resurrected. It is astonishing how this idea has struck the minds of so many would-be inventors, who, if they only consulted the archives of the patent offices, would learn that it has been "discovered" over and over again, to say nothing of the numberless inventors who have made no efforts to protect it.

No less a personage than the governor of a British Crown colony, on a trial trip which he honored by his presence, presented me with the suggestion, which he assured me he had thought about a great deal, but his official duties left him no time to experiment and perfect it. He was astonished when I informed him that I had heard of it for years, and that the scheme was impracticable.

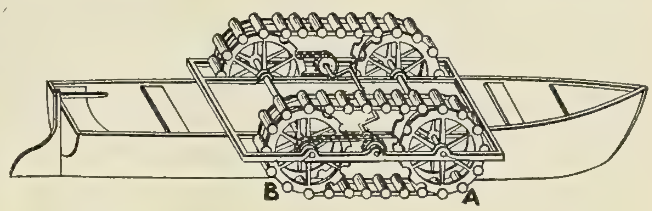


FIG. 1.

The idea is to have an endless chain or belt fitted with numerous paddles and revolving about two drums, one near each end of the vessel; apparently the longer the ship the more paddles will come in operation, and the faster will she travel. Devices for feathering the floats flat when moving forward and other constructive details need not be considered here; it is only the fallacy of the principle that I will endeavor to elucidate.

For the purpose of illustration I borrow Fig. 1 from a back number of this journal. One of the floats enters the water at *A* and emerges at *B*. Assuming, for argument, that slip is non-existent, the boat will travel this distance, which we will make equal to the circumference of the wheel at the center of effort.

As this float emerges at *B,* another one is just entering the water at *A*. It is obviously superfluous to have a train of floats or paddles between these two, although they are so shown on sketch. The one float traveling sternwards is pushing back a body of water equal to its area, but unless those in its wake can travel faster they have no propulsive effect; the floats following at same speed merely add weight and friction.

Allowing for losses due to obliquity of the floats entering and leaving the water, the advancement of the boat per revolution is, in this case, the distance between the centers of the wheels; if we double the distance we would have to give the wheels another turn to push the boat that much further for-

ward, but it would be no use adding more paddles. In an ordinary feathering wheel, the work done by each paddle—eliminating slip—pushes the boat forward a distance equal to the chord of the arc of immersion $c\ d$ (Fig 2). As the paddle passes the bottom center its useful effort diminishes, but the work is being taken up by the succeeding blade, and so the action is continuous. What advantage would be gained by

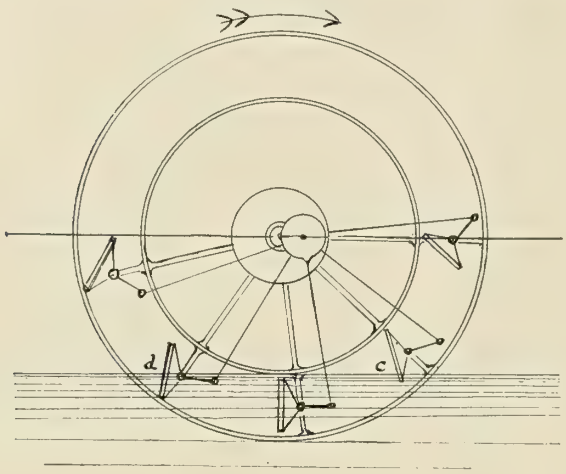


FIG. 2.

causing the blade to follow up the stream sent astern, unless its motion could be accelerated, it is difficult to see.

If an instantaneous photograph be taken of the wheel of a rapidly moving vehicle, the spokes of the upper half appear to be traveling much faster than those of the lower. Take a point P (Fig. 3), in half a revolution it will arrive at P_1, and the vehicle will have moved forward $\frac{3.1416}{2} = 1.5708$; but P will only have traversed in a forward direction that distance, less the diameter of the wheel. From P_1 to its original position at P the point has to travel horizontally 1.5708, plus the diameter of the wheel in the same period of time; hence

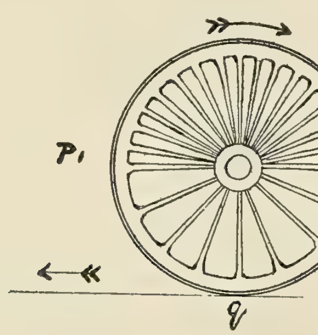


FIG. 3.

the apparent paradox of the top half of a wheel running with twice the velocity of the lower half.

This seemingly impossible feat is accomplished when the point is revolving about a center which is moving, but if the path of the point on arriving at q be continued laterally, as shown by the arrow, another point traveling in the opposite direction covers exactly the same distance in the same time, the acceleration appearing in the upper left-hand quadrant of the rear wheel being but transferred from the front one. It will thus be seen that the only propulsive effect obtained by the belt-paddle system is that due to one wheel, the other and the intervening chain of floats being merely incumbrances.

THE PACIFIC LINER LURLINE.

BY HOLLIS F. BENNETT.

The *Lurline* is a three-masted, schooner-rigged vessel of the spar-deck type, with raised forecastle, poop and 'midship house. Uncommon with large Pacific liners of this class, the ship has her machinery placed in the stern of the vessel under the poop deck, as is common with vessels on the Great Lakes.

She was built by the Newport News Shipbuilding and Dry Dock Company for the Matson Navigation Company, of San Francisco, for use as a passenger and freight steamer, in that company's service between San Francisco and Honolulu and ports on the Hawaiian Islands. The construction of the vessel was carried out to full Lloyds requirements throughout.

HULL DATA.

The general dimensions are as follows:

Length between perpendiculars..	420 feet.
Length over all.................	436 feet.
Beam, molded.................	53 feet.
Depth	33 feet 6 inches.
Draft	26 feet.
Displacement, 26-foot draft.....	10,000 tons.
Trial speed, burning coal........	14.6 knots.

The hull is of mild steel throughout, built especially strong and rigid. The keel is of the flat-plate type, connected to a wrought-steel stem, 12 by 3⅛ inches, and to the steel stern frame, which is 12 by 7¾ inches. There are five watertight bulkheads, and the frames are spaced 26 inches apart. It is noteworthy that the bulkhead between the engine and boiler rooms is non-watertight. There are five decks, the lowest, the orlop, extending from the stem to the after end of No. 1 hold. The main and spar decks extend the whole length of the ship, and, like the orlop deck, are of steel throughout, the spar deck being sheathed with 3 by 2½ yellow pine in way of forecastle, poop and 'midship house. 'Midships are the upper and bridge decks, both of wood.

The 'tween decks are specially designed for the carriage of package freight, while the holds are fitted for carrying raw sugar in sacks, which constitutes the principal cargo from the Hawaiian Islands.

The main and the orlop decks divide the forepeak into three sections, the lower being used for trimming, the middle section and the orlop deck for the stowage of chains, and the upper section on the main deck for the spare sails, ropes, cargo, gear, etc.

The crew's quarters are forward, under the forecastle head, together with the carpenter shop, boatswain's locker and windlass engine. In the 'midship house, on the spar deck, are located the dining saloon, the pantry, ladies' and men's baths and fourteen staterooms. On the upper deck are the smoking room and the social hall and six staterooms. Two of these rooms are outside rooms, arranged en suite with private bath. The dining saloon is finished in white and gold, as are all the staterooms. The social hall and smoking room are finished in mahogany, with upholstery done in dark brown. On the bridge deck are the wheel house, chart room and the captain's room and officers' quarters.

Aft, under the poop, are the engineers' quarters, together with the quarters for the oilers, water-tenders, firemen, cooks and waiters. The galley, officers' and crew's mess rooms are also located on this deck (spar). The *Lurline* has three steel masts with derrick booms attached, as follows: The foremast, four 8-ton and one 15-ton; mainmast, four 8-ton; mizzenmast, one 5-ton, for handling weights in the engine room. She is equipped with two bower, one stream and one kedge anchors, all stockless. The windlass is of the Hyde Company's make. The foremast and mainmast are each equipped with four of the Murray Iron Works (of San Francisco) single-drum, reversible high-speed cargo winches. For steer-

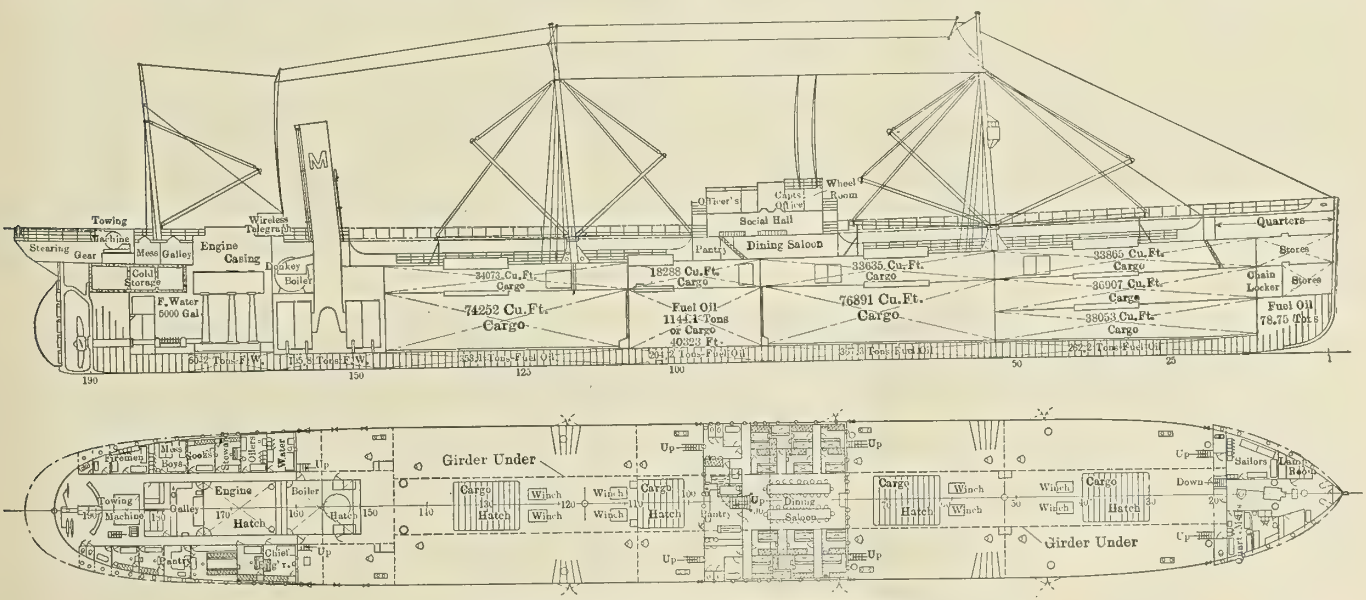
ing, she is fitted with Brown's patent steam tiller and telemotor gear. Four 22-foot metallic lifeboats make up her equipment.

The ship's masts are secured in her in a noteworthy manner. Contrary to usual practice, they do not go through the spar deck, but rest upon it, stayed by extra heavy wire rigging, with the bases secured to the deck by four braces made up of plate and angle bars.

THE LURLINE AT ANCHOR IN SAN FRANCISCO HARBOR.

MACHINERY.

The ship is propelled by one fore-and-aft triple-expansion engine, with cylinders 31, 50 and 84 inches diameter, with a common stroke of 54 inches. The cylinders are arranged with the high-pressure forward, followed by the intermediate and the low-pressure in the order named. The cylinder walls are 1½ inches thick, with no liners fitted. The valves are all forward of their respective cylinders, and are of the 15-inch piston type in the high and intermediate, and of the double-piston slide type on the low-pressure cylinders; there being one on the high-pressure, two on the intermediate and one on the low-pressure cylinder, and all the valves are fitted with balance pistons. Stephenson valve gear is fitted with cast-iron sheaves, cast-steel straps and forged-steel rods and stems. The links are the double-bar type, and with the link block are of wrought steel. The pistons are all of cast iron, fitted, in the high and intermediate-pressure cylinders, with ramsbottom rings. The piston rods are of wrought steel, 7 inches in diameter. The connecting rods are wrought steel, 6⅝ inches and 8 inches in diameter, and 10 feet 2 inches from center to center. The crossheads are wrought steel, with slippers of cast iron, lined with babbet metal. The engine is supported on cast-iron, box form, back and front columns, bolted to a cast-iron bedplate. The crank shaft and pins are 16½ inches diameter, and are joined by wrought steel webs, 87 inches long by 54 inches wide. There is a 14 by 20-inch reversing engine, and an 8 by 6-inch turning engine fitted to the main engine. The main steam pipe is 10 inches diameter. The engine room extends the full width of the ship up to the main deck. On the main deck, on the port side, is the dynamo and ice-machine room, and on the starboard side is the engineers' workshop and tool room. The ship is fitted with a complete cold storage plant on the main deck aft of the engine room casing.



INBOARD PROFILE AND DECK PLAN OF THE LURLINE.

BOILERS.

There are five Scotch return tubular boilers, four main boilers and one donkey boiler. The main boilers are 16 feet 4 inches mean diameter and 11 feet 6 inches long, built to withstand a working pressure of 180 pounds per square inch. Each boiler has four Morison furnaces, 39 inches in diameter

and 17/32 inch thick, attached to separate combustion chambers. The grate surface for one boiler is 78 square feet; heating surface tubes, 2,222 square feet; heating surface furnaces, 216 square feet; heating surface combustion chambers, 288 square feet; total heating surface for one boiler, 2,726 square feet. The net area of the tubes in one boiler is 13.75 square feet, and the length of grate bars, 6 feet. The ratio of heating surface to grate area is 35 to 1, and of grate area to tube area 5.68 to 1.

The boiler shells are 1 13/32 inches thick, the back and front heads and tube sheets are ¾ inch thick. There are double butt-straps treble riveted, the outside 1 1/16 inches and the inside 1 13/32 inches thick. The main stays are 3⅛ inches diameter, upset at the ends to 3½ inches and spaced 14 inches center to center. There are 254 ordinary tubes, No. 11, B. W. G., 8 feet 1¼ inches long, expanded into both tube sheets, and 106 stay tubes, 5/16 inch thick, screwed into both tube sheets. All tubes are 3 inches inside diameter.

AUXILIARY MACHINERY.

The condenser is independent, with cast-iron shell and ¾-inch brass tubes. The circulating pump of the single-acting centrifugal type with an independent engine, 11 by 11 inches. The suction and discharge pipes are 15 inches in diameter. The other pumps are as follows: Air pump, one Blake twin beam, vertical, 10 by 23½ by 15 inches with 9-inch suction from condenser and 8 and 5-inch discharges to feed tank and bilge. Main feed: Blake special duplex center-packed plunger pump, 12 by 7 by 10 inches. Auxiliary feed: duplicate of main feed. Donkey boiler feed: one Blake center-packed duplex plunger pump, 7½ by 3½ by 6 inches. Fire and bilge: one Blake horizontal duplex, 10 by 7½ by 12 inches. Ballast pump: one Blake special duplex, 12 by 10 by 12 inches. Fresh water pump: Blake duplex, 6 by 4 by 6 inches. Sanitary pump: Blake duplex, 6 by 4 by 6 inches. Fuel oil pumps: two Blake duplex 6 by 4 by 6 inches. Evaporator feed pump: one Blake duplex, 4½ by 2¾ by 4 inches.

FIG. 1.—THE FOCA AT CRUISING SPEED.

DONKEY BOILER.

The donkey boiler is a two-furnace single-end Scotch boiler, 11 feet 6 inches mean diameter and 10 feet 6 inches long, built for a working pressure of 180 pounds per square inch. There are two Morison furnaces, 44 inches in diameter and 17/32 inch thick, with a common combustion chamber. The grate surface is 44 square feet; heating surface, tubes, 1,170 square feet; furnaces, 114 square feet; combustion chamber, 137 square feet; making a total heating surface of 1,421 square feet. The net area of the tubes is 6.03 square feet, and the length of grate bars 6 feet. The ratio of heating surface to grate area is 32.25 to 1, and of the grate area to tube area 7.3 to 1.

The boiler shell is in two courses, 1 5/32 inches thick, the heads and tube sheets are ¾ inch thick. There are eight main stays, 2⅞ inches diameter, upset at the ends to 3¼ inches diameter, spaced 15 inches center to center. There are 176 ordinary tubes, No. 10 B. W. G., and 66 stay tubes, 5/16 inch thick, 7 feet 6 inches long and 2½ inches inside diameter. The hydraulic pressure is 360 pounds per square inch for all boilers.

There is one four-bladed, right-handed, built-up propeller, with cast-iron hub and manganese bronze blades; diameter, 18 feet; pitch, 20 feet; pitch ratio, 1.11; disc area, 254 square feet; helicoidal area, 115 square feet; projected area, 98 square feet; net area, divided by disc area, equals .453; projected area, divided by developed area, .85; rake, 10 inches; hub, 4 feet 5 inches diameter by 3 feet 1 inch long.

There is also fitted in the after part of the poop a Chase's improved towing machine of extra large size.

After completion the *Lurline* loaded 5,800 tons of New River coal at Newport News for the use of the fleet at San Francisco, and had her 'tween decks filled with 2,300 tons for bunker use. She sailed at 3.30 P. M., March 28, 1908, and the engines ran continuously, with the exception of one hour, when the vessel was stopped to tighten up the high-pressure piston rod packing, until Puerta Arenas was reached on April 26, at 1 P. M. After leaving Puerta Arenas the engines were never stopped until the ship anchored in San Francisco Bay on May 20, after a voyage of fifty-three days. The average day's run was 280 miles. Nearly 3,000 tons of coal was burned during the voyage, part of the cargo being used, with an average daily consumption of 54 tons per day. A good average reading of the engine's performance is as follows:

Steam, 175 pounds; vacuum, 24.5 inches; intermediate receiver, 35 pounds; low-pressure receiver, 4.5 pounds; revolutions per minute, 64; indicated horsepower, about 3,200; speed, 10.6 knots.

Upon arrival at San Francisco the grates were taken from the furnaces and the oil-burning system installed. On her first voyage from San Francisco to Hilo and Honolulu she made the run from port to port, a distance of 2,150 miles, in five days and twenty-one hours, at an average speed of 15 knots. She was loaded at the time with about 1,800 tons of general cargo. On the return trip she was loaded with 9,000 tons of raw sugar, and was seven days eight hours out, with an average speed of 12.4 knots.

THE ITALIAN SUBMARINE TORPEDO BOAT FOCA.

The Royal Italian submersible torpedo boat *Foca,* built by the Fiat-San Giorgio, Ltd., Spezia, Italy, is constructed with the *Laurenti* type of hull, which has been used in the Italian navy since 1905. The *Squalo, Narvalo, Otaria, Glauco* and *Tricheco* are all examples of this type. The *Laurenti* system of hull construction is radically different from that usually adopted in the construction of submersible boats. From the cross section, shown in Fig. 3, it will be seen that the usual circular shape has been discarded for one which allows better utilization of interior space without the necessity of large displacement. For instance, if, after the preliminary designs for a submersible have been made, it is found that to accommodate the necessary machinery will require an internal breadth of 3½ meters (11.48 feet), with a circular-shaped hull, it would be necessary to have a boat 3½ meters (11.48 feet) in diameter with a consequently large displacement. With the *Laurenti* type of hull the height may be reduced, as in this case, to 2 meters (6.56 feet), which gives ample room for installing the machinery and, at the same time, decreases the displacement of the boat. Not only is the smaller tonnage an advantage for practical maneuvering, but with the smaller boat and same propelling machinery it is possible to realize both a greater surface speed and a greater radius of action.

Circular-sectioned hulls do not give any warning of the amount of stress to which they are subjected while under external pressure, unless the stress exceeds the ultimate strength of the material and collapse occurs. On the other hand, with the *Laurenti* type of hull, since the cross sections are in the form of elastic arches, it is possible to follow their deformations under external pressure and by means of proper calculations obtain exact data regarding the magnitude of the stresses caused by the external pressure.

The principal dimensions of the *Foca* are as follows:

Length over all, 139.35 feet; beam, 16.25 feet; draft, maximum, 8.27 feet. The boat is propelled by three screws, each driven by a group of internal combustion motors of the Fiat type of about 300 horsepower each. The central motor is located in a watertight compartment, which can be shut at the very last moment before diving, and, as there is no need of using the after part of the boat in submerged navigation, it is possible to keep the central motors in operation until the exact spot is reached where it is intended to submerge the boat.

On her official trials the *Foca* maintained a speed of 15 knots for two consecutive hours, with her three motors developing only 820 horsepower. After this trial the motors were run at 600 revolutions per minute, and an eight-hour run was made on which an average speed of 12.2 knots was attained. With the central motor alone operating at 620 revolutions per minute, the cruising speed was found to be 10 knots, and the consumption of fuel only 125.69 pounds per hour. The fuel tanks are capable of carrying 17,140 pounds of fuel, consequently the radius of action at a speed of 10 knots is about 1,400 nautical miles.

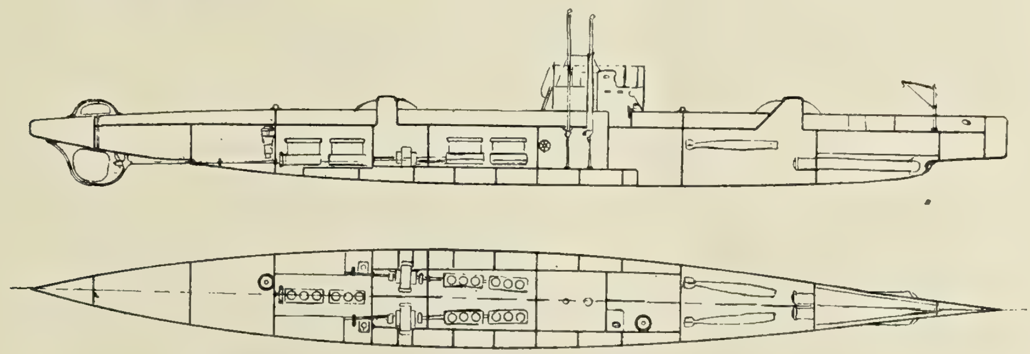


FIG. 2.—GENERAL ARRANGEMENT OF THE FOCA.

The *Foca* was kept submerged for some time in the neighborhood of the Gulf of Spezia, with her keel at a depth of 144 feet below the surface of the water. All deformations of the hull were found to be absolutely elastic, and the boat and fittings in perfect condition after the trial.

The conning tower is located a little forward of amidships, and is built of strong, nickel-steel plates. There are three means of gaining access to the boat, and, consequently, good ventilation can be secured. When submerged the boat is driven by electric motors developing about 110 horsepower each. Her radius of action in this condition is 65 nautical miles at a speed of 6 knots.

Besides the main propelling machinery, the following auxiliaries are installed: Two electrically-driven suction pumps, capable of exhausting 130 tons of water per hour each from a depth of 131.2 feet. These pumps are to be used for exhausting the water ballast in case the compressed air supply is insufficient. There are two air compressors of the Whitehead type, and also two electrically-driven auxiliary pumps.

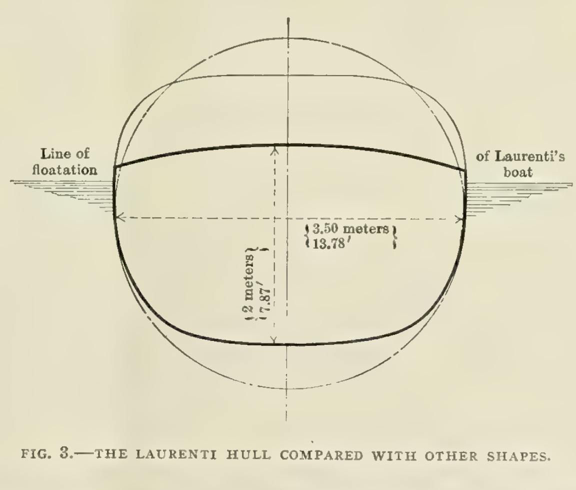
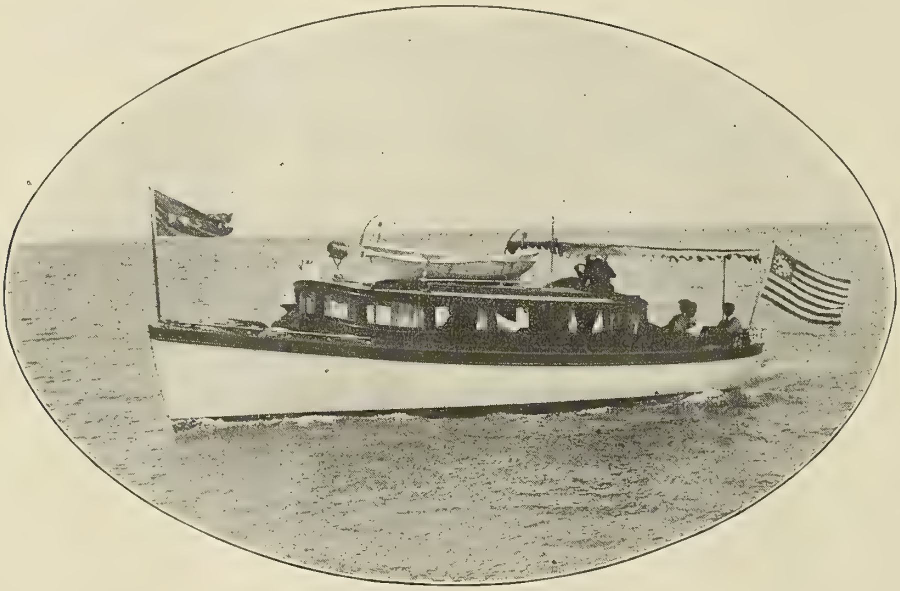


FIG. 3.—THE LAURENTI HULL COMPARED WITH OTHER SHAPES.

The boat is fitted with two torpedo tubes for 18-inch Whitehead torpedoes, and has a capacity for carrying four torpedoes.

THE MOTOR BOAT MARENGING.

Probably the most interesting American-built motor boat to be placed in commission this season is the *Marenging,* designed and built by the Truscott Boat Manufacturing Company, St. Joseph, Mich., for H. L. Aldrich, publisher of International Marine Engineering. This boat is unique in that she is propelled by a producer gas plant. She has been fitted with this type of power plant solely for experimental purposes, in order to determine the feasibility of using producer gas for marine work, and during the next few months the most complete and exhaustive tests which can be made will be carried out on this plant to determine the advantages and disadvantages of this type of motive power.

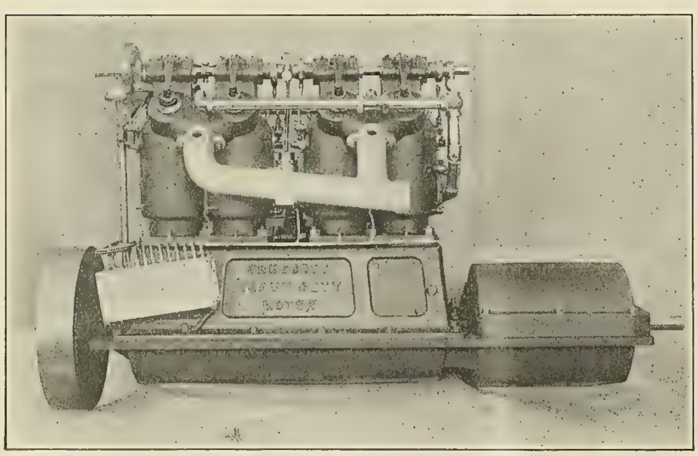


MARENGING AT FULL SPEED.

The principal dimensions of the boat are as follows:

	Feet.	Inches.
Length over all	40	0
Length on waterline	38	6
Beam	9	0
Draft, mean	2	6
Freeboard at lowest point of sheer	2	9
Sheer	0	6

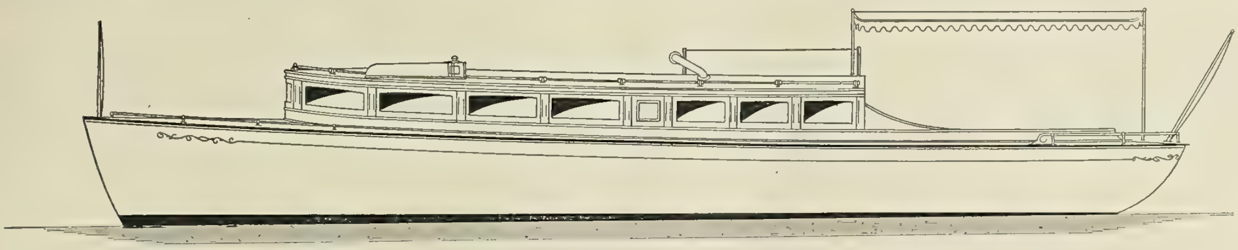
The keel is of good quality white oak, sided $3\frac{1}{2}$ inches, molded 4 inches, cut in long lengths and joined to the stem and deadwood with brass bolts and nuts. The frames are of solid, straight-grained white oak, steam-bent to shape, the smallest being $1\frac{1}{2}$ by $1\frac{3}{4}$ inches, spaced 9 inches center to center. Oak floors, provided with limber holes, are fitted to every frame. This permits the passage of bilge water without the necessity of cutting the frames. The hull is planked with clear, red cypress, $1\frac{1}{8}$ inches thick, smoothed on both sides. All butts are made between frames with oak reinforcements. The sheer strake is of selected white oak, and all fastenings are copper-riveted over large washers upon the inside. A watertight bulkhead extends from the keel half-way to the deck at the bow, just aft of the tank. The wales are put in with as long lengths as possible, and are of yellow pine and white oak, 2 by $3\frac{1}{2}$ inches, securely fastened with bolts. The deck beams are of oak, $\frac{7}{8}$ inch thick and $2\frac{1}{2}$ inches deep. The deck is of Honduras mahogany 1 inch thick. The frame work of the cabin, the fenders, strake and moldings are all of white oak.

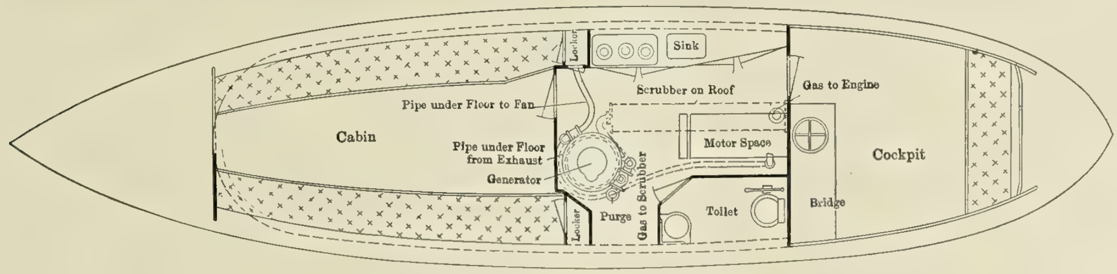


FOUR-CYLINDER MOTOR OF THE MARENGING.

The forward part of the boat is taken up entirely by the main cabin, the design of which is a compromise between the old-style full glass cabin and the newer type of hunting or turtle-back cabin, combining the advantages of both. The trunk of the cabin, which extends a moderate height above the deck, is composed entirely of heavy plate-glass sashes, which can be dropped down for the purposes of ventilation. As these sashes are absolutely watertight and of extra strength, the boat loses nothing in seaworthiness by this arrangement, whereas the additional comforts of plenty of light and good ventilation are secured. The main cabin, including an extension of 2 feet below the forward deck, to afford two full sleeping lengths, is 13 feet long. Wide seats, suitable for bunks, are built on each side of the cabin, with lockers underneath, accessible by means of lids on the top and hinged doors on the side. Both the interior and exterior of the cabin are finished in Honduras mahogany, the interior being built up of panel work cut from the solid wood.

Aft of the main cabin are the engine room, galley and toilet. The engine room and galley are 9 feet long and the toilet 5 feet long. Full-length wardrobes are built into the forward engine-room bulkhead. Besides the power plant the engine room contains the necessary lockers, etc., for tools, oil cans and accessories. The galley is fitted with a stand for a stove, and the space on top of the stand and behind it is sheathed with copper. Below the stand there are commodious cupboards for stores.



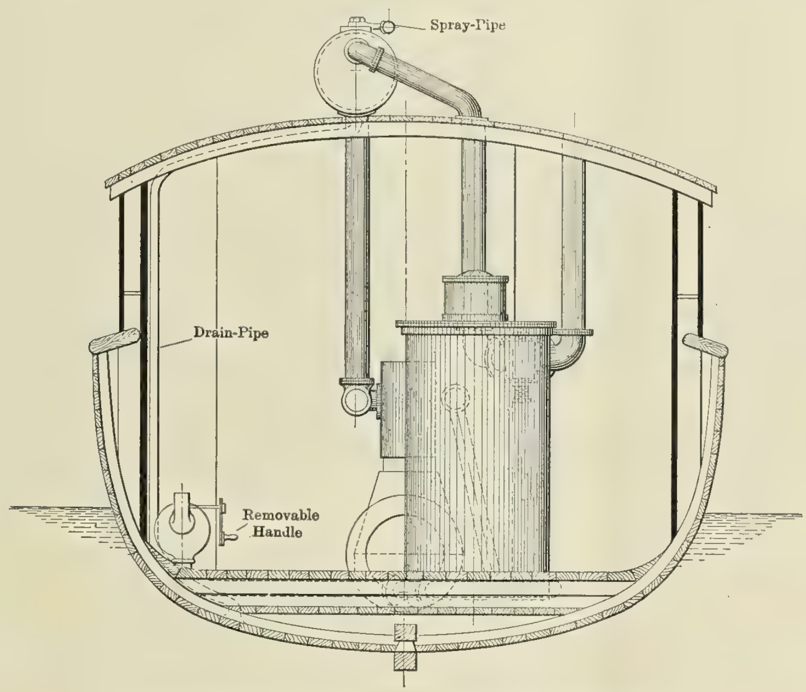


GENERAL ARRANGEMENT OF THE MARENGING.

Aft of the engine room is the cockpit, which, including the bridge, is 8 feet 6 inches long. The floor of the cockpit is raised to a height above the waterline sufficient to permit self-bailing. It is slightly crowned and pitched to drain through scupper holes in the forward corners. The floor is supported by stanchions to make it thoroughly rigid and solid. A cushioned locker extends across the rear of the cockpit, while the bridge is located just aft of the cabin. Contrary to the usual practice in a boat of this length, the cabin may be entered not only through a door in the rear of the engine room, but also through a watertight hatch in the forward deck.

The top of the cabin is sufficiently strong to support any reasonable weight. It is made of matched white pine, covered with a double layer of heavy paraffin parchment, upon which 12-ounce double-filled duck is tightly stretched and treated with three coats of paint. The carlins which support the roof are of Honduras mahogany, to match the interior finish.

Power is furnished by a 35-horsepower producer gas plant, consisting of a single-suction gas generator and a Truscott heavy-duty, 4-cylinder, 4-cycle engine, having cylinders 5¼-inch bore by 6-inch stroke. The engine is fitted with a reversing gear mounted in an extension of the main bed. The cylinders are bored and reamed to size, and are fitted with long cast-iron pistons. The crank shaft is of drop-forged steel, and the bearings are of genuine Babbitt metal of very large size. Lubrication is effected by a force-feed mechanical oiler attached to the front of the engine and driven from the cam shaft. The oil ducts lead, respectively, to the pistons and crank case of each cylinder and to the forward and after bearings. All of the moving bearings are provided with snap oilers. The inlet and exhaust valves are both mechanically operated, and are located in the cylinder head in removable cages. The cam shaft is located above the cylinders on the longitudinal center line of the engine. The cams are forged integrally with the shaft, and have large ground surfaces for contact with the valve lift-arm rollers. Ignition is of the



ARRANGEMENT OF THE GAS PRODUCER, ENGINE AND AUXILIARIES.

low-tension make-and-break type, mechanically operated from the cam shaft. The exhaust pipe of the engine is water cooled, extending beneath the cockpit floor, and is submerged beneath the stern of the boat. The reversing clutch is of the improved gear type, fitted with large surface in both gear and pinions, and it is self-oiling.

The bronze propeller wheel is of the three-bladed pattern with solid flukes. The propeller shaft, stern bearing, stern tube and stuffing-box are all of bronze. The stuffing-box is on the inside of the boat, and can be reached through a hatch in the cockpit floor. The bronze shoe, or skeg, for supporting the rudder, is fastened to the keel with long brass lag screws.

The engine is completely fitted with all of the necessary wrenches for access or repair to any part; lubricators, oil cans, etc., together with a complete set of spare valve gear, bolts, nuts, cotter pins, washers, etc.

The gas for the operation of the engine is generated in a single-generator suction gas producer, built by the Marine Producer Gas Power Company, 2 Rector street, New York. The producer is 24 inches in diameter and 4 feet high. The shell is made of tank steel, and is lined with a special grade of firebrick lining, at the bottom of which is attached a shaking grate, available through a cleaning and ash-pit door for the inspection of the fire and the removal of ashes. The fuel is charged into the producer through an automatic vestibuled charging hopper, so arranged as to preclude the possibility of admission of air to the upper zone of the producer. The hot gas is taken off at the top of the producer through a special three-way valve having one common connection with the producer, arranged on one side with a purge stack, and on the other side with a connection leading to the Monel metal gas scrubber, which is located on the deck house over the engine room. This scrubber is 12 inches in diameter and 6 feet long, weighing 60 pounds. In the scrubber the gas is passed through numerous sprays of water, which cool it and cleanse it of all dirt and soot, and prepare it for its proper use in the engine. The gas leaves the scrubber at the after end through a lower connection, and passes directly to a gas and air-mixing valve which is substituted for the ordinary carburetor. This valve is arranged for the proper control of the mixture of gas and air, and also acts as a throttle in order to give the desired speed to the engine.

The operation of the plant is, briefly, as follows: A fire is kindled on the grate, and coal is charged into the top of the producer until the fire is of a proper depth for correct gas making. When hurried starting is desired, a fan, which is located in the locker on the starboard side of the boat, is operated by hand. The air leaving this fan enters the producer underneath the grate, passes up through the fire, and the products escape through the purge pipe until the fuel is heated to the proper gas-making temperature, when the purge valve is closed and communication made with the gas scrubber. A small vent pipe near the engine is then opened to the atmosphere, and the fan turned until gas appears at this vent. This fan is only used in starting the producer, and as soon as the engine is under way the operation of the fan ceases.

The proper adjustment of gas and air is then made at the gas-mixing valve, the spark retarded as usual, and the engine turned over by a special crank furnished for this purpose. By this operation gas and air in the proper proportions are drawn into the cylinders and there compressed, and at the end of the compression stroke the mixture is ignited. The engine immediately comes up to speed, and can be operated with the clutch in a neutral position, or ahead or astern, as desired. The suction stroke of the engine creates a vacuum in the gas main, which communicates with the producer, and serves to draw the proper proportion of air and ingredients through the fire of the producer to make the gas.

The fuel commonly used is anthracite coal of pea or buckwheat size, although either charcoal or coke may also be used. During operating periods the fuel is charged into the gas producer, and the grate is agitated in order to shake down the ash at intervals of from one to two hours. After the boat is docked, or has been moored, and the engine is shut down, the purge valve is put into communication with the purge pipe, and the grate is again shaken, and the ashes, after being wet down, are removed from the ash-pit. The producer is then replenished with fuel, and the fire left in a stand-by condition for an indefinite period. After a twenty-four-hour shutdown, only ten or fifteen minutes blasting with the fan is necessary to bring the fire up to the proper gas-making temperature, when the customary cycle for starting can be carried out.

The gas generated is uniform in character, and has such consituents that preignitions are practically done away with. The temperatures obtained in the cylinders are not nearly so high as with gasoline, and the engine can be operated much easier than with gasoline. Variations in temperature and humidity do not affect the operation so much as with the latter fuel, but for successful operation on producer gas the engine must be fitted with large inlet and exhaust valves and pipes. The Truscott motor used in this installation required no changes in this respect, inasmuch as the valves and piping supplied for gasoline are unusually generous in size, the only changes being in the nature of considerably higher compression than ordinarily met with on gasoline operation, the compression in this instance being 150 pounds per square inch above atmospheric pressure. The initial maximum pressures are about 300 pounds per square inch immediately after ignition, and the mean effective pressure for the working stroke on the piston is about 70 pounds per square inch.

About 1¼ pounds of anthracite pea coal of good quality are consumed per horsepower per hour. The total weight of coal carried, therefore, but slightly exceeds the weight of gasoline which would be ordinarily carried for such a plant operating on this fuel. The engine, complete with clutch, shaft, propeller and fittings, weighs 1,650 pounds. The gas-generating plant, complete with producer, scrubber, fan, purge valve, pipe, fire tools and fittings, weighs 1,000 pounds, a total of 2,650 pounds, or 76 pounds per horsepower.

The control of the plant is so arranged that both the boat and the motor can be handled by one operator on the bridge in the cockpit. Steel rods and levers passing beneath the floor are actuated by tooth and sprocket levers from an automobile type of starting wheel on the bridge. The steering wheel has a brass hub and stanchions, and is fitted with a wooden rim, finished to match the rest of the woodwork. An additional wheel, placed directly below the steering wheel, actuates the reversing clutch, and connections mounted on the bulkhead control both the spark and throttle. An improved type of lock switch is arranged for easy access for starting and stopping the motor. The control levers on the engine are so arranged that they can be operated by the engineer if desired.

The producer plant and engine are finished in black enamel with trimmings of polished brass, the whole outfit lending itself nicely to the handsome finish of the boat.

The annual meeting of the Institution of Naval Architects will be held March 31, April 1 and 2, in the hall of the Society of Arts, John street, Adelphi, London, W. C. The Right Honorable Earl Cawdor, president of the Institution, will preside over the meetings. The programme includes the usual varied subjects of interest covering both naval architecture and marine engineering, and the convention promises to be one of much interest.

THE ITALIAN BATTLESHIP ROMA.

BY DAGNINO ATTILIO.

The dock trials of the last of the 12,500-ton Italian battleships of the *Vittorio Emanuele* class have recently been completed. This ship is the *Roma,* which was launched April 21, 1907. The other battleships of the class, which are already in commission, are the *Vittorio Emanuele, Napoli* and *Regina Elena.* The principal dimensions of the *Roma* are as follows:

Length over all	474 feet 6 inches.
Length between perpendiculars	435 feet.
Beam, extreme	73 feet 6 inches.
Draft, mean, trial	25 feet 9 inches.
Displacement, trial	12,625 tons.
Launching weight	6,000 tons.
Coal supply, normal	1,000 tons.
Coal supply, maximum	2,000 tons.
Steaming radius at 10 knots	10,000 miles.
Estimated speed on trial	21½ knots.

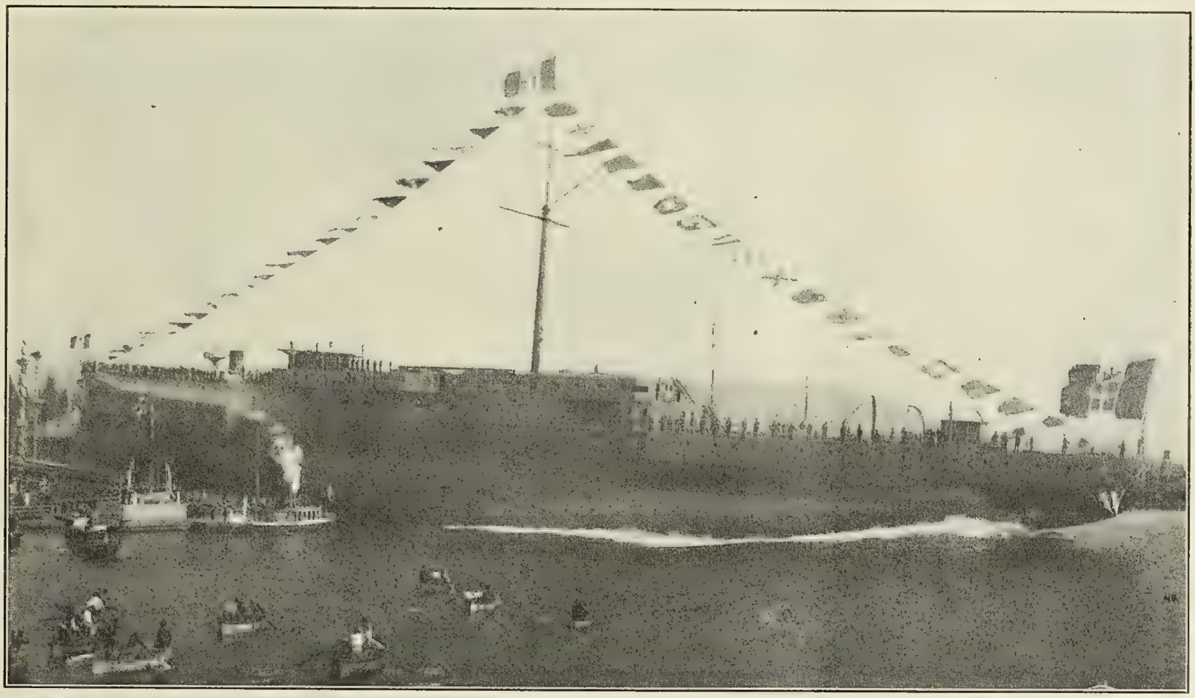
The hull is of steel throughout, and the stem and stern posts and propeller brackets are of cast steel. The armor, which is face-hardened, is distributed as follows: A 10-inch waterline belt extending the length of the machinery space, tapering to 4 inches at the ends; a central redoubt of 8-inch armor and a 3⅛-inch protective deck, worked in forward. The large turrets have 10-inch armor and the smaller turrets 6-inch armor.

The armament consists of two Armstrong 12-inch, 40-caliber, 51-ton guns, mounted on the centerline of the ship, one forward and one aft. Each gun has an arc of fire of 300 degrees, and fires a charge of powder weighing 450 pounds and a projectile weighing 850 pounds, capable of perforating 13 inches of Krupp armor at a distance of 2,000 yards. The rest of the main battery consists of twelve 8-inch Armstrong 45-caliber, 19½-ton guns, mounted in pairs in turrets amidships. These guns fire a projectile weighing 230 pounds, and are capable of perforating 7 inches of Krupp armor at a distance of 8,860 feet.

The secondary battery consists of eight 3⅛-inch, 40-caliber guns; four mounted in barbettes, two at the bow and two at the stern, the remaining four being distributed in commanding positions at the sides. There are also twelve 1⅞-inch rapid-fire guns, four canister guns and two 3-inch landing pieces. The total weight of the bow or stern fire is 2,554 pounds, while the total weight of the broadside fire per minute is 3,042 pounds.

It is noteworthy that the 6-inch guns usually employed for the secondary battery on Italian battleships are absent in the *Roma.* It is claimed by Mr. Cuniberti that, since the 6-inch guns can penetrate only 3 inches of modern armor at a range of 3,000 yards, this gun is ineffective against highly-armored vessels at probable battle ranges, while for the chief work for which they would be used—that is, driving off torpedo boats and small craft—the 3-inch guns are almost equally effective.

The *Roma* is propelled by two sets of triple-expansion engines, designed to develop 20,000 indicated horsepower, giving the ship a speed of 21.5 knots. Steam is supplied by fourteen Babcock & Wilcox watertube boilers. With a bunker capacity of 2,000 tons of coal the estimated steaming radius at cruising speed is 10,000 miles. Electricity is used throughout the vessel for lighting, steerage, hoisting ammunition and operating the turrets.



LAUNCH OF THE ROMA AT SPEZIA, ITALY.

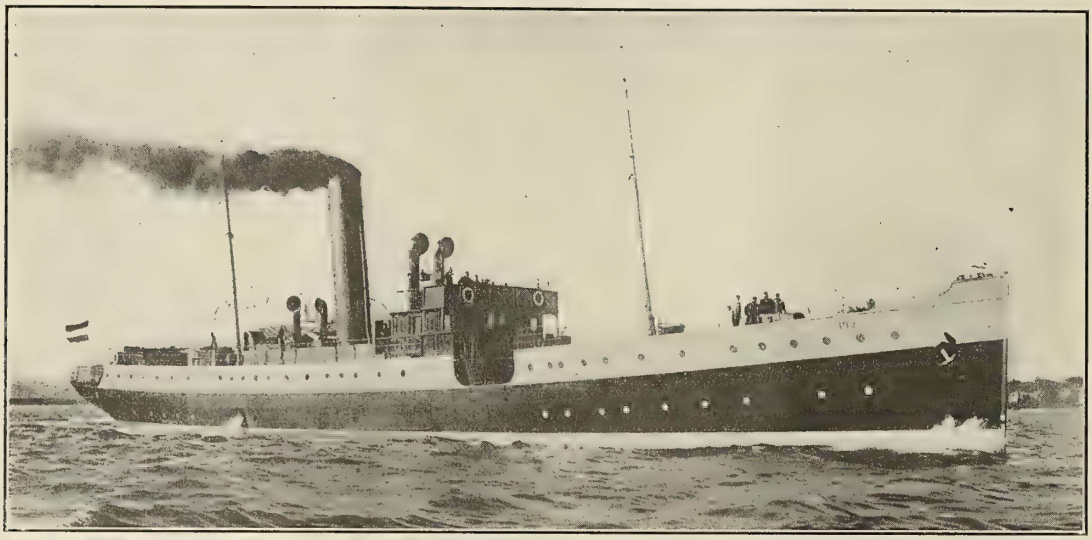
A New Transatlantic Record.

On Feb. 11 the Cunard steamship *Mauretania* arrived off Sandy Hook, having made the run from Daunts Rock, Queenstown, 2,890 miles, in 4 days 17 hours 50 minutes. This is 1 hour 46 minutes less than the best previous record made by the *Lusitania.* On the second day out the *Mauretania* logged 671 miles, making an average speed of 26.84 knots. The average hourly speed for the entire voyage was 25.55 knots. This record, made as it was during the winter months, when the weather conditions were not all that could be desired, seems to indicate that during the coming summer this ship will be able to average a much higher speed than was possible last year. The changes made in her wing propellers have greatly reduced the vibration of the hull, besides adding to the speed.

Swiss Steam Turbines for Ship Propulsion and Lighting

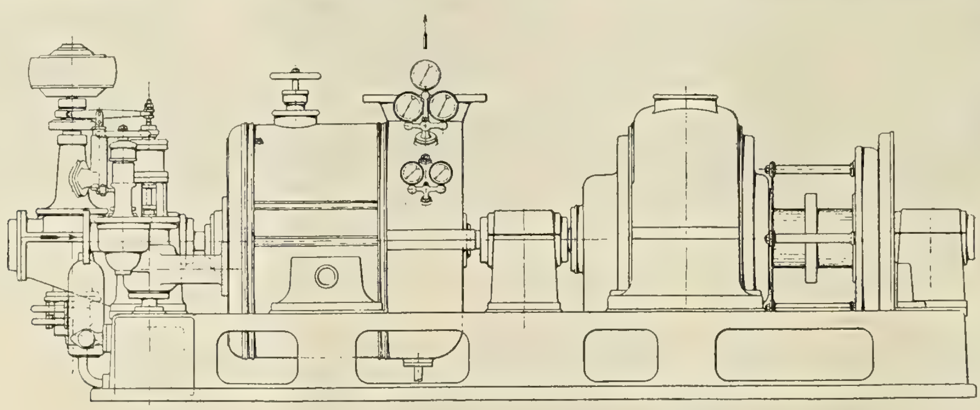
BY FRANK C. PERKINS.

It is unnecessary, at this time, to go fully into the question of steam turbines for ship propulsion or for electric lighting on shipboard; but it may be of interest to consider the design and construction of a Swiss steam turbine as applied to marine service, for driving a modern steamer, as well as for operating the electric light and power plant required on such a vessel. The steam turbine is best applied to steamship propulsion when propeller wheels are used and the boats are operated at high speed almost continuously; while for side-wheel river and lake steamers, as indicated by the *Blümlisalp* and *Rhein*,* the reciprocating engine has been used exclusively up to the present time.



A GERMAN-BUILT STEAMER EQUIPPED WITH ZOELLY STEAM TURBINES FOR PROPULSION.

One illustration shows the Zoelly steam turbine in the shops of the hydraulic turbine builders, Escher, Wyss & Co., Zurich, Switzerland, as completed and ready for installation in the mail steamer *D. S. S. 392*, shown in another illustration, and built at the Howaldt shipyard, at Kiel, Germany. The total capacity of this turbine is 1,000 horsepower, and it is held that on account of the strong construction of the blades and wheels, and the absence of clearances, in the Zoelly steam turbine, it promises to do better than reaction turbines in the realization of a rational marine turbine.

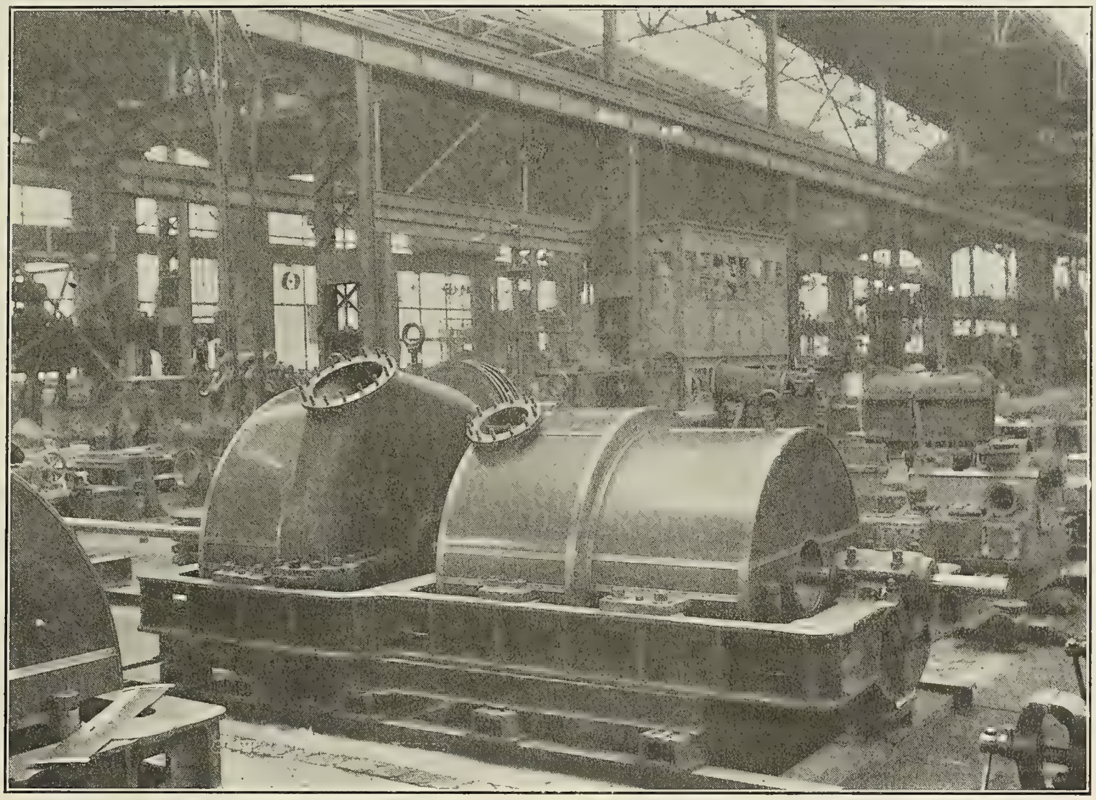


ZOELLY STEAM TURBINE AND DIRECT-CURRENT GENERATOR FOR LIGHTING ABOARD SHIP.

The drawing shows one of the Zoelly steam turbines directly coupled to a direct-current generator for lighting aboardship. It is held that for economy, regulation and reliable service, the steam turbine-driven ship lighting set is ideal. These plants are fitted on the steamers *Blümlisalp* and *Rhein*, and equipped with engines and boilers by Escher, Wyss & Co. The lighting plant consists of a 10-horsepower compound wound direct-current dynamo supplying current at 110 volts pressure for lighting and power service, directly coupled to a steam turbine. This set operates 90 incandescent lamps on each steamer, as well as two arc lights, and is located just forward of the inclined reciprocating propelling engines, as shown in the lower plan on page 443, November, 1907.

In order to operate reciprocating engines at their highest economy, and also to get the best results from steam turbines, either for propulsion or for electric lighting service, the steam supplied must be superheated to a considerable degree. The steam turbine can be supplied with superheated steam at much higher temperatures than reciprocating engines, as with the latter difficulties arise in the matter of lubrication, which are not encountered with the former. In the present case the two boilers are of the Schmidt-Escher-Wyss design, fitted with superheaters, and operated at a pressure of 147 pounds per square inch. The direct heating surface measures 1,280 square feet; the superheating surface, 305 square feet; and the grate area, 31 square feet. Each boiler has a steam space of 88 cubic feet, 154 heating tubes 3 inches in diameter, and sixty superheating tubes 1.1 inches in outside diameter. The superheating tubes are placed within a flue contained in the boiler, and forming, in itself, a part of the water-heating surface. There are two Morison suspension furnaces, 31½ inches in diameter.

* *International Marine Engineering*, November, 1907, page 442.



ZOELLY MARINE STEAM TURBINE OF 1,000 HORSEPOWER IN THE SHOPS OF THE BUILDERS AT ZURICH.

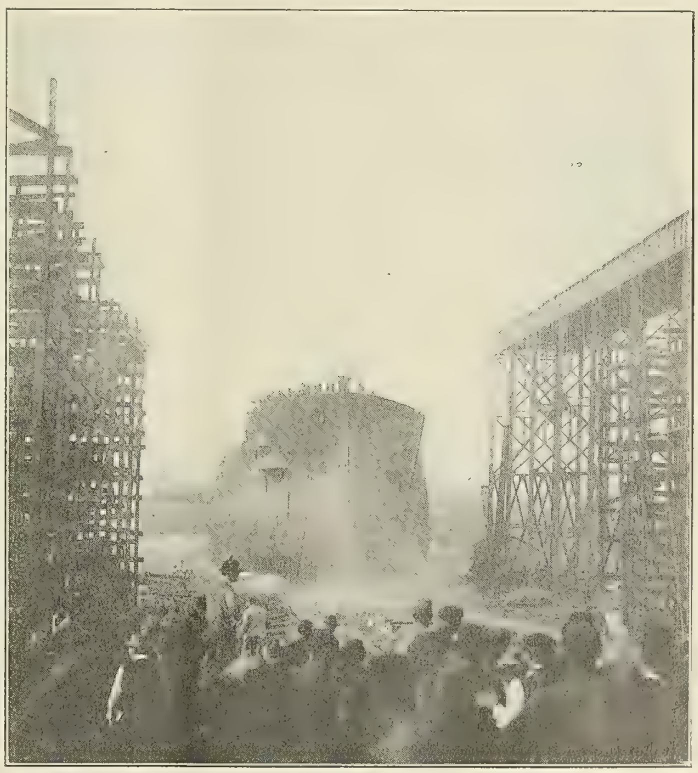
THE LAUNCH OF THE DELAWARE.

The second American *Dreadnought* was launched from the yards of the Newport News Shipbuilding & Dry Dock Company on Feb. 6. She was christened the *Delaware* by Miss Anne Pennewill Cahall, of Bridgeville, Del. The *Delaware* is a sister ship of the *North Dakota*, launched on Nov. 10, 1908, in the yards of the Fore River Shipbuilding Company, Quincy, Mass. Each vessel has a displacement of 20,000 tons, and is designed for a speed of 21 knots. In the *Delaware* propulsion will be by means of two four-cylinder, triple-expansion, direct-acting, reciprocating engines, designed for an indicated horsepower of 25,000, while in the *North Dakota*, Curtis turbines of the same total horsepower are being installed. Babcock & Wilcox watertube boilers are used in both vessels.

The *Delaware* is 519 feet long over all, with a beam of 85 feet 2⅝ inches and a draft at a displacement of 20,000 tons of 26 feet 10 inches. Her armament consists of ten 12-inch breech-loading rifles, mounted in pairs in revolving turrets on the centerline of the ship, in such a manner that all of the 12-inch guns can be fired on either broadside, four of them ahead and four of them astern. The secondary battery comprises fourteen 5-inch rapid-firing guns for repelling torpedo-boat attack. These guns are mounted partly amidships and partly at the bow and stern on the gun deck. There are also four 3-pounder rapid-firing guns, four 1-pounder semi-automatic guns, two 3-inch field pieces, two machine guns of .30 caliber, and two 21-inch submerged torpedo tubes.

The ship is heavily armored, a waterline belt 8 feet wide extending the entire length of the ship. This belt is 11 inches thick amidships, tapering to 4 inches bow and stern. It extends 6 feet 9 inches below the full-load waterline. The side armor is 10 inches thick, which is reduced to 5 inches at the main deck. The 12-inch turrets are protected by 12-inch and 8-inch armor.

The contract for the *Delaware* was awarded to the Newport News Shipbuilding & Dry Dock Company on Aug. 6, 1907, and the keel was laid Nov. 11, 1907. The contract price for the hull and machinery was $3,987,000 (£820,000).



LAUNCH OF THE U. S. BATTLESHIP DELAWARE.

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A Successful Cruise.

For years large fleets of merchant vessels have been steaming regularly month after month back and forth on long ocean voyages, arriving and departing on schedule time, and encountering every condition of wind and sea without serious mishaps or accidents to the propelling machinery or auxiliary apparatus. This reliability has been accepted without comment; but when it was proposed to send a fleet of sixteen American battleships on a year's cruise, first to the Pacific Ocean and finally completely around the world, doubts were freely expressed of the ability of the warships to successfully withstand such a test. The successful completion of this cruise is a splendid refutation of the many criticisms which have been made regarding the quality and reliability of naval machinery. The ships have been at sea fourteen months, and during that time have covered a distance of 42,000 miles without a serious mishap or accident of any kind. Furthermore, at the end of the cruise four of the largest and most recently built ships are able to report no repairs necessary. Such a record as this is greatly to the credit of the designers and builders of the vessels and the men who have had charge of the operation of the machinery en route. Not only have all the officers and men greatly improved in efficiency, as evidenced by the high records achieved at target practice and in the carrying out of battle maneuvers and in the successful navigation of the ships through difficult places under all conditions of weather, but also the records from the stokeholds and engine rooms show that much has been accomplished in the way of increased economy in coal consumption.

Undoubtedly the greatest defect brought out by the cruise is the lack of colliers. A sufficient number of vessels of this type capable of maintaining the requisite speed is absolutely essential to ensure the mobility of the fleet in time of war.

The Motor-Boat Show.

The fifth annual national motor boat show was held at Madison Square Garden, New York City, from February 15 to the 23d, under the auspices of the National Association of Engine and Boat Manufacturers. The display this year, both in size and excellence, greatly surpassed all similar exhibitions which have previously been held, and bore ample testimony to the size and importance which this branch of marine engineering has assumed. Interest in the exhibition was manifested not only by sportsmen and yachtsmen, but also by that rapidly growing class of men who find use for small power craft in commercial pursuits. In the early days of motor boating the question of the complete design for a boat was not as carefully considered as it is to-day, and the results, both as to appearance and performance of the boat, frequently left much to be desired. The present-day motor boat, however, particularly if it is of large size or built for speed, is the result of careful designs by a competent naval architect, who designs not only the shape of the hull and the interior arrangement, but also designs the power plant for the boat. The result of this has been not only the gradual sifting out of the hundreds of nondescript designs and the substitution of recognized types, but also the development of different types of engines especially suited for different purposes. This change is doing much to insure the reliability and success of motor boats, and as soon as the benefits of a harmoniously designed boat are more fully recognized much greater progress can be looked for.

A Gas-Propelled Motor Boat.

This month we are able to publish in detail a description of the 40-foot gas-propelled motor boat which has just been brought out by the publisher of this journal for experimental purposes. Ever since the first attempts were made to use producer gas for the propulsion of ships widespread interest has been aroused in this form of motive power; but as this has taken the form of speculation rather than of investigation, only meager data covering the performance of such installations has been available. It is with a view of obtaining such data that the *Marenging* has been built,

and as soon as practicable an exhaustive series of tests will be made on the boat to determine the reliability and economy of a modern marine producer-gas plant. The results of these tests will be published from time to time during the coming months, so that our readers will have an opportunity to judge as fairly as may be from the performance of such a small plant the feasibility of using producer gas for marine work. These tests, together with those which will be made on the auxiliary yacht *Carnegie*, which is to be equipped with a 150-horsepower gas-producer plant, will at least furnish a chance for comparison with other fuels, which will be of value both to manufacturers and shipowners.

One result which might be looked for if these early installations prove successful in every way is the development of auxiliary sailing vessels as cargo carriers to compete with tramp steamers. Vessels of the large schooner type are the most economical cargo carriers afloat; but at present they lack means of assuring definite time of arrival at a port of destination, and, due to their inability to overcome the handicap of adverse weather conditions, are able to show an average speed of not much more than four or five knots, as against eight or nine knots for the tramp steamer. The remarkable records for fast sailing which have been made by cargo schooners under favorable conditions lead us to believe that, if some economical form of auxiliary power, such as a producer gas plant, could be installed, the average speed of such ships could easily be brought up to a point which would enable them to successfully compete with tramp steamers.

Revision of the United States Laws Relating to the Safety of Life at Sea.

Last May President Roosevelt appointed a commission, consisting of Capt. Adolph Marix, chairman of the Lighthouse Board; Charles Earl, solicitor of the Department of Commerce and Labor; Eugene T. Chamberlain, Commissioner of Navigation; George Uhler, Supervising Inspector-General of the Steamboat Inspection Service, and Commander William Strother Smith, of the United States Navy, to make a careful investigation of the laws of the United States enacted for the better security of life at sea, with a view to their better adaptation to present needs. After careful inquiry, this commission has made its report in the form of a bill into which are incorporated the present laws, carefully revised as seemed necessary to the commission, and such new matter as seemed desirable in view of present needs. The bill is very long and is divided into six articles, dealing respectively with the marine-inspection service, the inspection of vessels and machinery, life-saving and fire-fighting equipment, the officers and crew, transportation of passengers and merchandise and the enforcement of the act. The provisions of this bill deserve careful consideration by every one whose interests are affected in any way by it, for some of its recommendations seem unnecessarily severe, such, for instance, as that requiring every motor boat, under penalty of $1,000, to have at least one substantial life-boat aboard. In an endeavor to make the inspection service as efficient as possible, the commission has recommended increasing the salaries of the supervising inspectors and local inspectors in order to assure the best class of men for the work and the best service. To relieve the inspectors of a great deal of work outside of the regular inspections of vessels, eight examining boards are to be created for the purpose of examining and licensing officers of the merchant marine and to try cases of misconduct. Under the present system such cases are first investigated and then the trials conducted by the same officials. This recommendation would be good if the number of boards provided were adequate, but it seems very doubtful if eight such boards could accomplish the work.

It is proposed to make more vessels subject to inspection than at present, not only to insure their being properly inspected and equipped, but also that they may have on board regularly licensed officers. All steam vessels and all motor boats carrying passengers for hire are to be subject to inspection. Also all steam and motor vessels of more than 35 feet between perpendiculars. It was considered advisable to make the measurements by length rather than by tonnage, as this is a simpler and just as satisfactory method. Instead of limiting the inspection of sail vessels to 700 gross tons or over, all sail vessels of 300 gross tons or over and all sail vessels of 50 gross tons or over, carrying passengers for hire, are to be included.

Apparently no discrimination is made between an ocean-going steamship and a small motor boat in the provision requiring that all steam and motor vessels carrying passengers for hire and engaged in a service which may at any time take them more than forty miles offshore shall be equipped with an efficient wireless telegraph apparatus, and shall carry a competent operator for the same.

Coming to the personnel on board of vessels, it is difficult to interfere with routine matter on board ship; and, furthermore, the usage in all merchant marines is such that it protects those serving on board from overwork, except in cases of emergency. There are some specific cases where complaints have been laid before the commission, which have received their attention, not only in justice to those whom it affects, but also for the safety of the passengers and the vessels. It is stipulated in the report that it will be unlawful for the master of a seagoing vessel to permit an officer to take charge of the deck watch, immediately after leaving port, who has not had at least four hours off duty before taking such watch.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

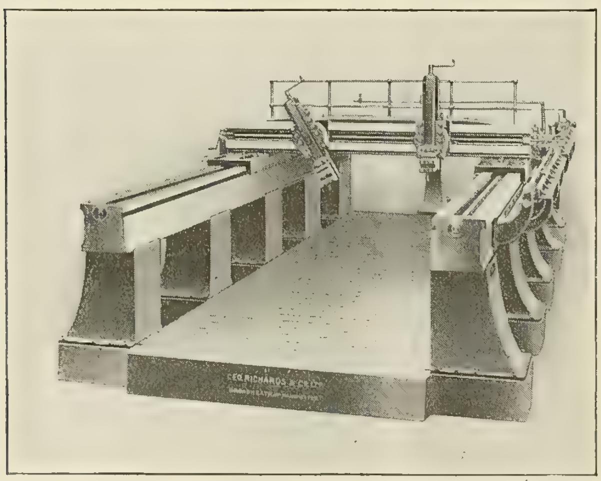
	Tons.	Knots.		Jan. 1.	Feb. 1.
			BATTLESHIPS.		
S. Carolina..	16,000	18½	Wm. Cramp & Sons..........	75.1	78.9
Michigan ...	16,000	18½	New York Shipbuilding Co..	85.1	89.7
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	59.0	64.1
North Dakota	20,000	21	Fore River Shipbuilding Co...	67.4	70.6
Florida	20,000	20¾	Navy Yard, New York......	0.0	3.3
Utah	20,000	20¾	New York Shipbuilding Co..	0.0	3.1
			TORPEDO-BOAT DESTROYERS.		
Smith	700	28	Wm. Cramp & Sons.........	62.8	65.2
Lamson	700	28	Wm. Cramp & Sons.........	61.8	63.8
Preston	700	28	New York Shipbuilding Co...	57.9	59.3
Flusser	700	28	Bath Iron Works............	50.0	55.3
Reid	700	28	Bath Iron Works............	48.5	54.6
Paulding ...	742	29½	Bath Iron Works............	3.0	3.7
Drayton	742	29½	Bath Iron Works............	3.0	3.7
Roe	742	29½	Newp't News Shipbuilding Co.	4.6	10.2
Terry	742	29½	Newp't News Shipbuilding Co.	4.8	9.5
Perkins	742	29½	Fore River Shipbuilding Co..	3.8	6.7
Sterrett	742	29½	Fore River Shipbuilding Co..	3.8	6.7
McCall	742	29½	New York Shipbuilding Co...	3.4	5.8
Burrows	742	29½	New York Shipbuilding Co...	3.3	5.8
Warrington..	742	29½	Wm. Cramp & Sons.........	0.0	6.2
Mayrant	742	29½	Wm. Cramp & Sons.........	0.0	6.5
			SUBMARINE TORPEDO BOATS.		
Stingray	...	..	Fore River Shipbuilding Co..	68.0	69.9
Tarpon	...	..	Fore River Shipbuilding Co..	66.9	71.0
Bonita	...	..	Fore River Shipbuilding Co..	63.0	68.4
Snapper	...	..	Fore River Shipbuilding Co..	62.3	65.6
Narwhal ...	...	..	Fore River Shipbuilding Co..	58.7	70.0
Grayling ...	...	..	Fore River Shipbuilding Co..	57.4	64.7
Salmon	...	..	Fore River Shipbuilding Co..	54.9	61.3

ENGINEERING SPECIALTIES.

A Turbine Planing Machine.

The machine consists of two beds, 36 feet 9 inches long, with sliding saddles and cross arm, the beds being supported by legs mounted on a heavy girder baseplate, 20 feet wide, 12 inches deep, and extending the entire length of the machine. The beds are of heavy section and the distance between them is 14 feet 2 inches, enabling the tool to plane across the top of work 14 feet wide and down the sides of work 12 feet wide, and to receive work under the tools 7 feet deep and 30 feet long.

The cross arm is driven backwards and forwards by pulleys through bevel gears, and two steel screws in the beds of 4



inches diameter, giving a cutting stroke of 35 feet per minute in either direction. On the cross arm are mounted two tool slides carrying the tool rams, which can be swivelled to any angle and have a down-feed of 30 inches in all positions. The reversing mechanism to the cross arm is quite independent of the feed arrangement, and the feed is only put on when the feed levers on the saddle come in contact with the stops, enabling the machine to be stopped or started by hand, in either direction, without putting on the feed. This reversing mechanism is operated from a platform placed at the back of the cross arm by a lever having a sector on the lower portion of it, which gears with a pinion on the square reversing shaft. On the end of this square shaft is another pinion, which gears with a sector and lever connected to a plate, which has scroll slots cut in it to receive rollers on the belt forks. There are two belts for driving the machine when on the cutting stroke, and two for the return stroke, to obviate the use of wide belts, which are not easily moved from one pulley to the other. The base plate is built up in sections, tongued and grooved, and securely fastened together by bolts, the top being planed true and having T-slots cut out of the solid. Along the side of the bed is a rail, which carries the feed and reversing stops and sliding bearings for the square feed and reversing shafts. These bearings are pushed along the rail by the saddle, and are so arranged that the shafts are always supported about half-way when the saddles are at the ends of the beds. The feed is operated by stops secured to the rail along the side of the bed, which, coming in contact with the feed levers, bring the clutch on the square shaft into gear, causing the feed disc to revolve, and through the feed levers move the feed pawl either forward or backwards, according to the direction in which the cross arm is traveling. This feed mechanism is so arranged that the feed can either be put on at the cutting end of the stroke or at the return end, or at both ends. The feed is varied by means of a plate at the side of the feed gear and a catch piece fixed to the feed pawl. To obtain the maximum feed, the plate is turned by means of a thumb wheel and pinion to such position that the recessed part of the plate occupies the arc made by the feed pawl, and the catch piece is therefore not affected by the plate, as the pawl is in gear from the commencement of its stroke. To shorten the feed, the plate is placed in such position that the catch piece, which is attached to the feed pawl, rides on the top of the feed plate until it comes opposite the recessed portion, when it allows the pawl to drop into gear and put on the feed. The maximum feed is 1 inch and the minimum 1/24 inch. For broad cutting, which, of course, is done with the machine cutting in one direction only, any feed up to 2 inches can be obtained.

The total weight of the machine is 75 tons, and it is adapted for taking heavy cuts, running at high speeds. Geo. Richards & Company, Ltd., Broadheath, near Manchester, are the manufacturers.

Towing Machines for Dredging Operations.

The use of towing machines of smaller sizes is rapidly growing in favor among dredging companies and contractors. They not only allow towing to continue under weather conditions that would otherwise be impossible, but they also save money in smooth water. The steel hawsers on the towing machines cost less, last longer, and do away with practically all the labor required for handling manila lines. The small machine shown in the illustration is one of several built by the American Ship Windlass Company, of Providence, R. I., for a progressive American dredging company. This machine has cylinders 7 inches by 7 inches, and uses a $\frac{7}{8}$-inch diameter steel hawser. This replaces 7-inch to 9-inch manila lines on small tugs. With the automatic winding device shown no after towing bitts are required. The machine is simply bolted in their place, and can be installed over night.

The large machine shown in the illustration is for installation on a large dredge now building in Scotland, designed for work on the Lagos Bar on the east coast of Africa. The dredge has to be equipped with such a device in order to allow for the swells and heavy seas that sometimes break over this bar.

THE EFFECT OF BOSSING UPON RESISTANCE.*

BY PROFESSOR HERBERT C. SADLER, D.SC.

In the course of testing some models of twin-screw ships with different shaped sterns, the writer had occasion to try the effect upon the resistance of placing the bossing at different angles, and it was thought that the results might be of interest to the members of this institution.

Before proceeding to discuss the results obtained in these experiments, the writer would call attention to the important part that some of these appendages might play in connection with the resistance of a modern vessel. Most of the passenger vessels of to-day are fitted with bilge keels, and nearly all with two; if not, in the case of turbine-driven vessels, three or four lines of shafting. The stream line flow around a vessel is still somewhat of an unknown quantity, although in a valuable paper by Naval Constructor D. W. Taylor, United States navy,† the probable path of the water has been indicated for a number of different types. A casual glance at these lines will show how easy it is to place an appendage in a most disadvantageous position, so far as resistance is concerned; in fact, the resistance might easily be increased 20 percent by improper design.

The following experiments, although applying directly only to the form tested, nevertheless indicate in a general way the course to be followed in placing the bossing for a twin-screw ship.

The following are the particulars of the model used: Length, 10 feet; breadth, 1 foot 3 inches; draft, 6 inches and 7 inches.

Draft.	Block Coeff.	Pris. Coeff.	Mid. Sect. Coeff.
6 inches.	.635	.663	.958
7 inches	.653	.677	.964

The model was first run "naked" at the above drafts, representing the medium and deep-load drafts in the actual vessel. The bossing was afterwards added to the same model. The two types of bossing tried are shown in Fig. 1, and represent practically the two extreme cases, viz.: one with the appendage horizontal and the other inclined at an angle of 45 degrees to the vertical. The form of the bossing is that in common use, the top being kept as straight as possible, while most of the curvature is on the underside; an arrangement which gives a more simple construction in connection with the plating than that where both the top and bottom have the same form.

The tests with the bossing were made at the same dis-

* Read before the Institution of Engineers and Shipbuilders, February, 1909.

† Society of Naval Architects and Marine Engineers, New York, 1907.

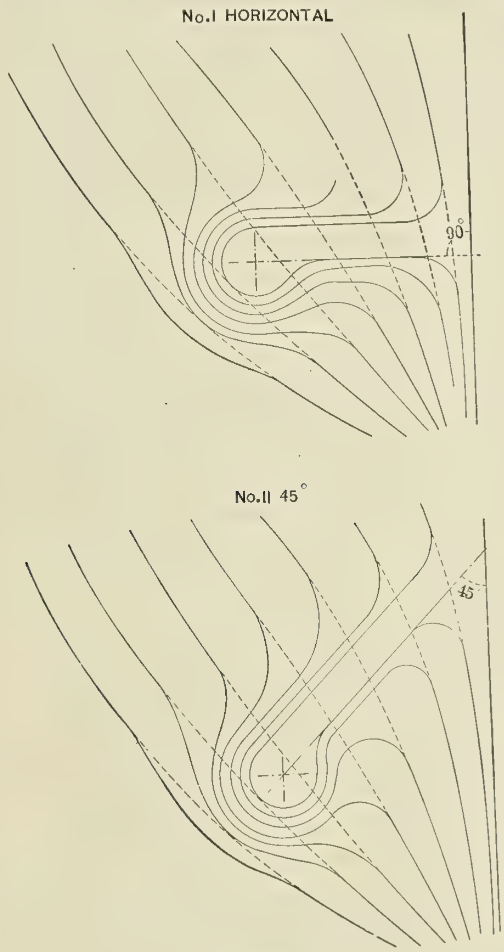


FIG. 1.

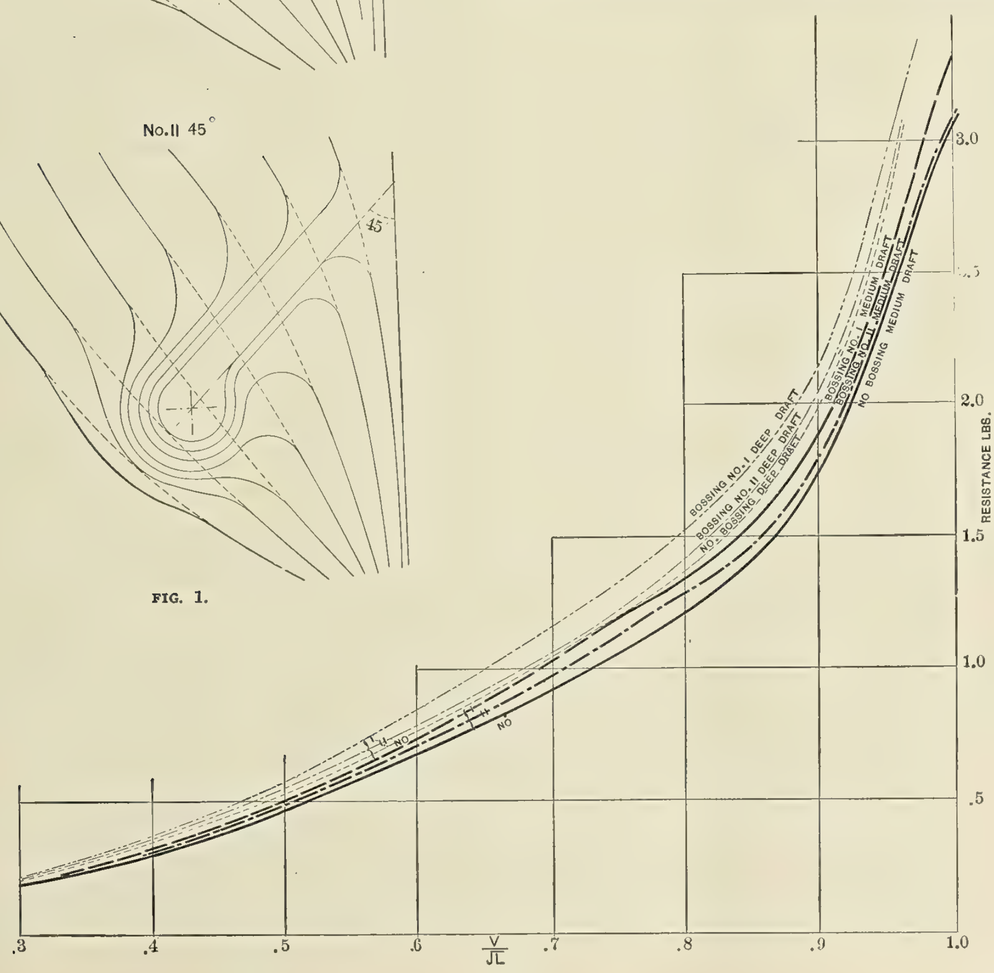


FIG. 2.

placement as that corresponding to the 6-inch and 7-inch drafts of the naked hull. This method was adopted in preference to that of equal drafts, as giving a more direct comparison. The difference in draft, due to the displacement in the bossing, is not great, as the additional displacement is only .84 percent for No. I. and .88 percent for No. II. bossing, Fig. 1. The net addition to the wetted surface is about 3 percent for the horizontal type, and about 3½ percent for the inclined type. The curves for total resistance are shown in Fig. 2, plotted to a speed-length ratio base, and give the results for both the medium and deep drafts.

Observation of these curves shows that at all practical speeds for this form the horizontal type of bossing is greatly inferior to the inclined type. Notwithstanding the fact that the latter gives an increased wetted surface between the limits of speed-length ratio of from .7 to .85, the increase in total resistance over that of the "naked" hull only varies from 3 to a little over 4 percent, while for the horizontal type the corresponding increase is from 10 to 11 percent.

The effect of the two systems is, however, better seen by referring to Fig. 3. In this case the residuary resistance is shown for the two displacements, the corrected surface friction in each case having been deducted.

Instead of actual residuary resistance, the resistance per ton of displacement is plotted, and instead of speed the abscissæ represent speed-length ratio, or speed in knots, divided by the square root of the length in feet. Mention is made of this method of plotting because the curves so obtained are independent of size or density of water, and will apply to any ship of which the model is a type. This has been adopted as the standard method of plotting residuary resistance, both at the University of Michigan and at the United

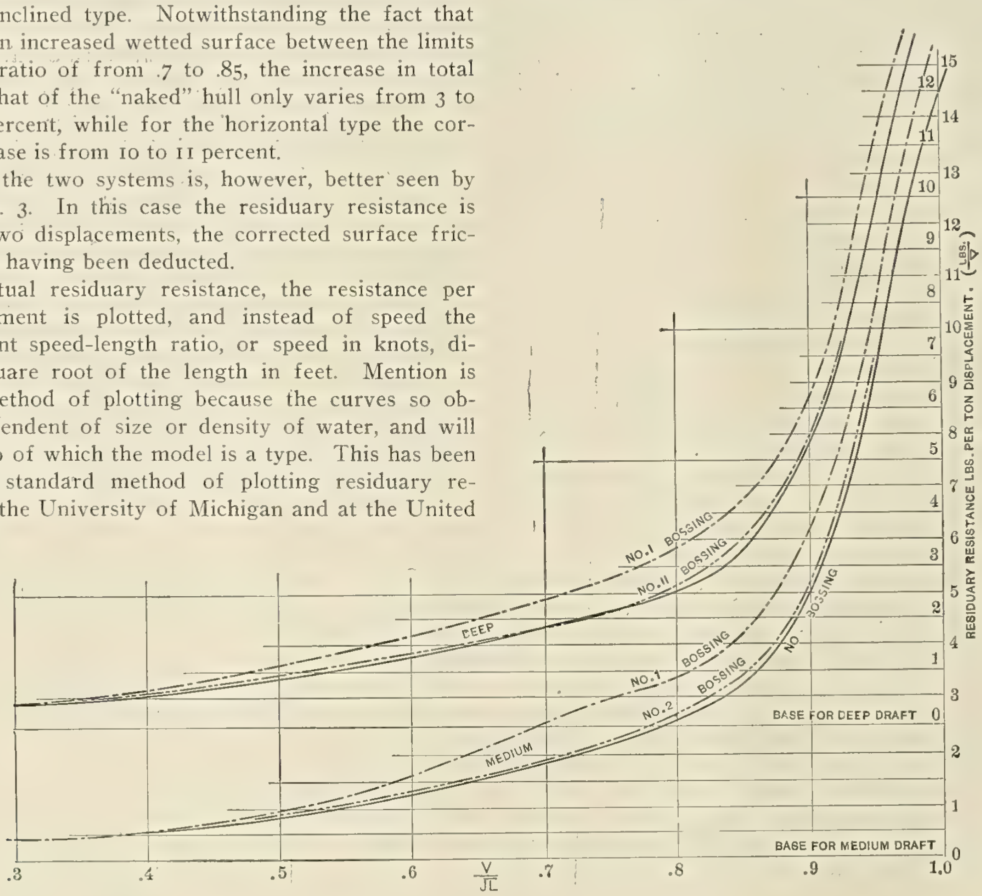


FIG. 3.

States government tank at Washington, and is the simplest form for direct application to practical problems.

Within the limits of speed-length ratios before mentioned, the inclined system of bossing for the two displacements increases the residuary resistance by a very small amount, which at some speeds is negligible, while in the horizontal type the increase averages from between 30 and 35 percent.

Comparing the curve of residuary resistance for No. II., or the inclined bossing with that of the "naked" hull, it is obvious that the stream line flow cannot have been materially changed in the two cases. This conclusion, to a certain extent, bears out Taylor's stream lines, and if the buttock lines of No. I. be compared with those of No. II., and also with the "naked" hull, the result is, perhaps, only what might have been expected.

The above experiments give, however, quantitative results for purposes of comparison, and emphasize the importance of attention to such details in design. Attention may also be called to the fact that a number of fast Atlantic liners have been fitted with horizontal bossing.

THE ROYAL MAIL STEAMSHIP "ARAGUAYA."

BY FRANK C. PERKINS.

The Royal Mail Steam Packet Company's steamship *Araguaya, of* 10,500 tons gross, was constructed at the Belfast shipyard of Workman, Clark & Company, Ltd., to Lloyd's highest requirements for first class passenger steamers. She is a steel twin-screw steamer, 515 feet long with 61 feet beam and a depth of 34 feet. The poop is 42 feet long, the bridge 274 feet and the forecastle 89 feet.

The propelling machinery consists of two quadruple expansion engines, with a stroke of 40 inches, and cylinders measuring 27, 38, 54 and 76½ inches in diameter. The main condensers are placed on the outside of the engines, and are attached to the back of the columns by brackets. The steam is condensed outside the tubes, the circulating water passing through them. There are large centrifugal pumps, capable of supplying the condensers with water to maintain the necessary vacuum even when the engines are running at full speed in the tropics with the sea water at 85 degrees F.

The crank, tunnel and propeller shafting is of steel, considerably increased in diameter beyond the Board of Trade requirements. The propellers are of bronze, each propeller having three adjustable blades, and constructed to turn outboard when driving the vessel ahead.

Steam is supplied by six boilers of the cylindrical multitubular type, all built of steel, and designed to carry a working pressure of 215 pounds per square inch, and so arranged as to be stoked from two holds. The boilers are fitted with forced draft on Howden's open-stokehold system, the air being supplied by two large fans, placed in recesses in the after stoke-

THE ROYAL MAIL STEAMSHIP ARAGUAYA.

hold. Each stokehold is also provided with See's ash ejectors, with subsidiary ash hoists in addition.

The *Araguaya* is constructed with a cellular double bottom, and, including the cargo holds, there are over thirty watertight compartments, so that with the invariable excellent discipline maintained by the Royal Steam Packet Company's commanders, she is as safe at sea as when in dock, and is practically unsinkable. Several of the main holds are insulated and fitted for the reception of meat cargoes, and the passengers' supplies are also stored in insulated chambers.

There has been provided complete ventilation by currents of pure air, forced throughout the ship by twenty-two large fans working at equal pressure, with a separate exhaust to eliminate the impurities. Other novel features include an electrically-operated fog syren, responding to the pressure of a button on the bridge; electric means for setting twenty-six clocks at each noon by instantaneous signal from the chart room, and hydraulic noiseless cranes to load and discharge cargo, saving the passengers from the irritating whirr of noisy steam winches.

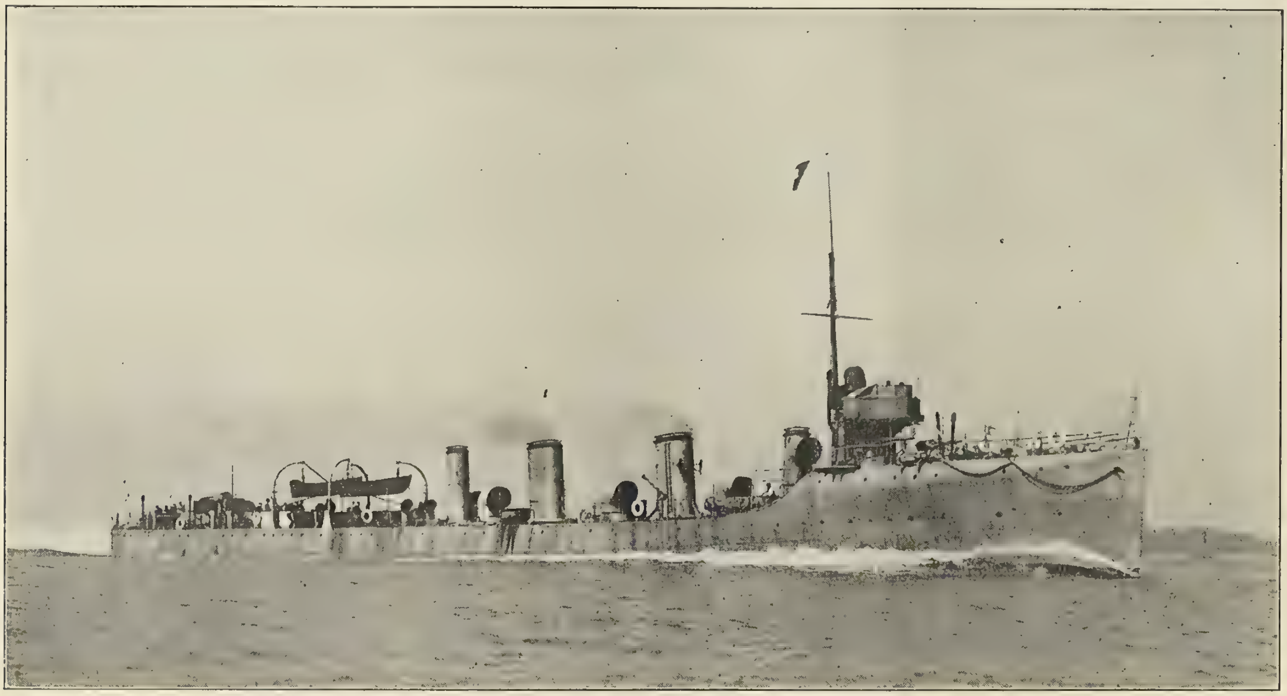
MAIN SALOON OF THE ARAGUAYA.

THE TORPEDO-BOAT DESTROYER "MOHAWK."

BY E. OMMELANGE.

The turbine-driven destroyer *Mohawk* is one of the most successful of the 33-knot ocean-going destroyers now in the service of the British navy. She is 270 feet long, with a beam of 25 feet. The propellers are supported on brackets, the central propeller, driven by the high-pressure turbine, being at a lower level, and 5 or 6 feet abaft the side propellers. The latter are attached to the shafts, on which are mounted a cruising and a low-pressure ahead turbine and an astern turbine.

The vessel is constructed with very fine lines forward, and, as in the "River" type, there is a high forecastle with a bridge, which commands a splendid view, not only of the horizon, but of the complete deck. Even at full speed and with the wind at full force, sending spray from the crest of every wave, no water found its way on to the forecastle from the beginning to the end of the trial trip, but the spindrift frequently washed over the waist of the ship. The hull is constructed entirely of high-tensile plates and angles, the tensile strength being from 37 to 40 tons per square inch; the rivets are of the same steel.



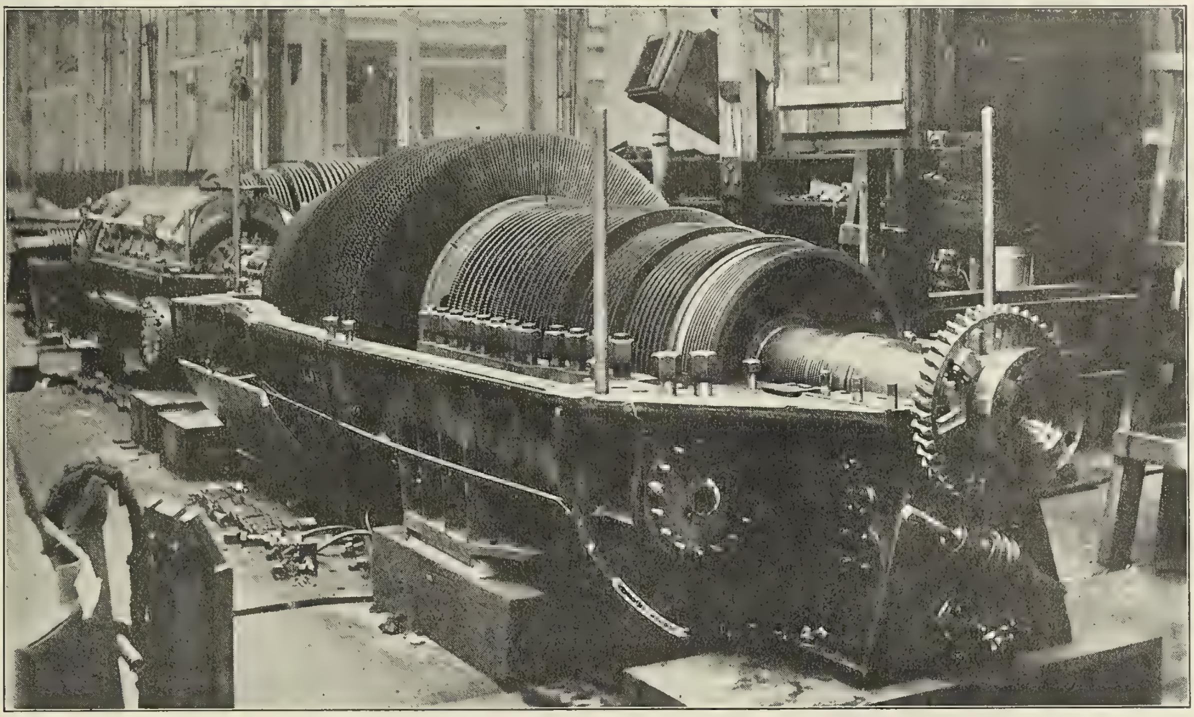
THE MOHAWK AT FULL SPEED.

The armament of the ship includes three 12-pounder quick-firing guns, two of them mounted forward and one of them aft, with two revolving tubes on deck for firing 18-inch torpedoes.

The propelling machinery, which is the most important feature of the ship, consists of Parsons steam turbines, supplied with steam from White-Forster watertube boilers, burning oil fuel on the Admiralty system. There are three main boiler rooms, each containing two boilers, all arranged on the center line of the ship. The foremost boiler and that next to the engine room have independent uptakes, while the other four are in pairs, each pair being divided by a center line bulkhead, but connecting with one funnel. The radius of curvature of each tube between one of the lower water drums and the upper steam and water drum is the same, and the curvature is only sufficient to determine the direction of movement due to expansion, and also to facilitate cleaning and repairs. The tubes are arranged in position in a transverse section, like the staves in a section of a barrel, and the continuation of the line of curvature of each tube, passing through the top drum in line with the end manhole, allows each tube to be inserted or withdrawn through this manhole, so that it is possible to withdraw any tube without disturbing the remaining tubes, and as every tube has the same curvature they can be readily cleaned internally by a tube brush having a rigid handle curved to the same radius. Large down-take tubes are fitted. Ordinary manhole doors are arranged on all drums. As the inclination of the generating tubes is considerable, and usually varies between 40 and 60 degrees, the circulation is definite and rapid, keeping the tubes free from deposit. No special water baffles or separator plates are found necessary, the usual internal steampipe being sufficient to give dry steam. Patent baffles are so fitted as to divide the uptake into two or more parts, in such a manner that the gases are drawn equally over the whole tube surface and at right angles to it, without offering any resistance or increasing the air pressure. Air holes are arranged at the sides and ends for the admission of air above the grates.

The boilers are worked on the closed-stokehold system, with forced draft, and on the trial the pressure averaged about 4 inches. In each stokehold there are a main-feed and auxiliary-feed pump, two fan-engines, and the pumps required in connection with the oil fuel. The oil-fuel tanks are at the ends of the ship.

The machinery includes seven turbines: a high-pressure cruising and intermediate cruising, a high-pressure main and two low-pressure main turbines—all for going ahead, with two astern turbines. One cruising, one low-pressure main ahead and one astern turbine are mounted on each wing shaft; the high-pressure main turbine alone is on the center shaft. It will be understood that at low power the sequence of steam is through the high-pressure cruising to the intermediate-pressure cruising, thence to the high-pressure main, and to the low-pressure main turbines. For intermediate speeds, the high-pressure cruising turbine is cut out, the steam from the boiler entering the intermediate-pressure cruising turbine, thence going to the high-pressure main turbine and to the low-pressure main turbines. For full speed both cruising

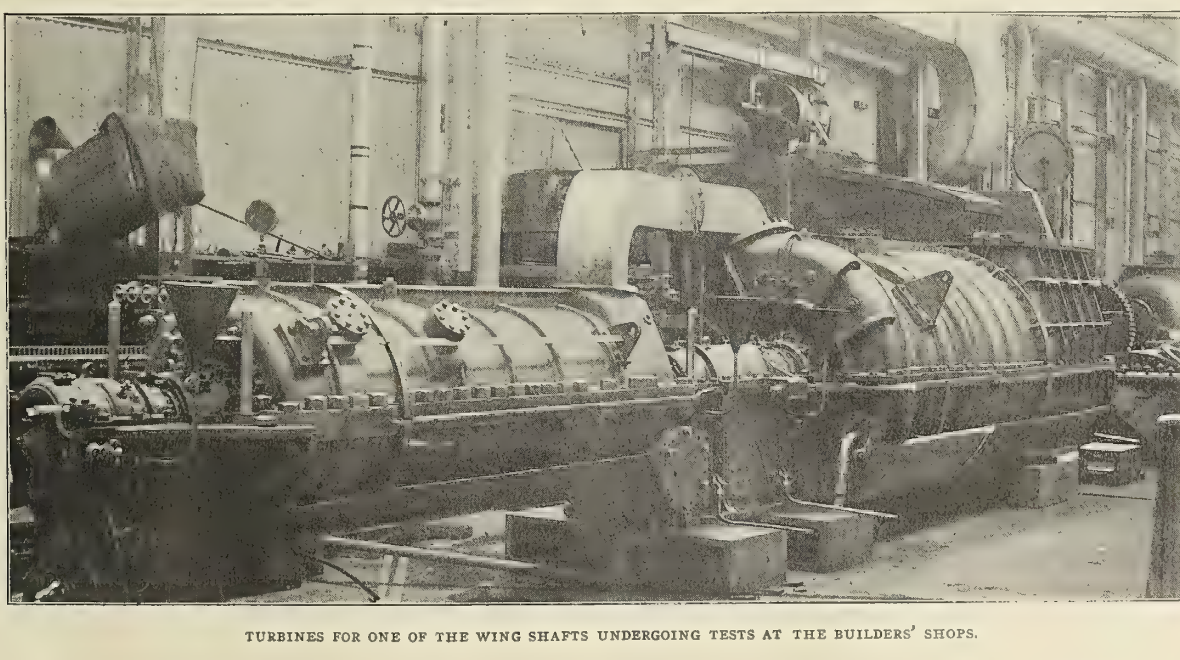


ONE CRUISING, ONE LOW-PRESSURE MAIN AHEAD AND ONE ASTERN TURBINE ARE MOUNTED ON EACH WING SHAFT.

turbines are out of action. This arrangement necessitates a considerable number of valves and a duplication of steam pipes. There are two main stop valves for the two main steam leads from the boiler room, with a cross connection between them. There are also connections from these to several other valves, mounted on the forward bulkhead in the engine room, so that the supply of steam can be passed direct from the boiler to any one of the seven turbines in the ship. The low-pressure ahead and astern turbines alone are used in maneuvering, the central shaft running idle. The starting platform is in the center of the engine room, between the low-pressure turbines, and all auxiliary engine stop valves for the various units in the engine room are workable from this position. In maneuvering the ship the two side wheels are used, and these, through shafts and bevel gears, communicate with a vertical lever fulcrumed at one end, so that when the valve of the ahead low-pressure turbine is opened the valve of the astern turbine is closed.

The arrangement of the engine room is very convenient, the various pipe connections to the side turbines being immediately over the high-pressure turbine. The condensers are in the wings, the circulating pumps being located at the forward end, while the dry-air pumps and wet-air pumps are situated on each side of the wing shafts aft. At the after end of the engine room there is a distiller and an evaporator, and their respective auxiliaries are located close by.

The rotors for the turbines vary in diameter from 31½ inches, in the case of the high-pressure cruising turbine, to 44½ inches in the high-pressure main turbine, and 66 inches in the low-pressure turbine. The blades range in length



TURBINES FOR ONE OF THE WING SHAFTS UNDERGOING TESTS AT THE BUILDERS' SHOPS.

from ¾ inch to 11 inches; the latter in the low-pressure ahead turbine have been fitted separately on the original Parsons system. Cast steel has been used for the discs, while forged steel was, of course, adopted in the case of the spindles, which do not extend through the rotors. In the case of the high-pressure turbine the thrust bearing is at the forward end, and in the other shafts it is between the cruising and the low-pressure turbines. The astern turbine, as is usually the case, is incorporated in the low-pressure ahead turbine, and the exhaust bend is built up of steel plates. The steam pipes are of steel, with gunmetal expansion pieces.

The propeller shafts are of forged steel, being 7½ inches in diameter, with a 3⅝-inch hole. The propellers are three in number, of Stone's manganese bronze, each with three blades.

THE PRINCESS CHARLOTTE IN DRY-DOCK.

The performance of the *Mohawk*, as regards speed, reliability, fuel economy and seaworthiness, was very satisfactory, and it is said that the vessel established a record in speed and in fuel consumption. The conditions of contract between the Admiralty and the constructors, Messrs. J. Samuel White & Company, of East Cowes, were that the vessel should maintain an average speed of 33 knots for six hours, a rate which was to be determined by the revolutions required per nautical mile from the mean results of six runs over the measured mile made at the middle of the trial. The vessel ran six times over the measured mile at the Maplin Sands, in the Thames Estuary, and her mean speed was then 34.511 knots, the mean revolutions being 757.3 per minute. On the six hours' run the average speed was, on the basis given, 34.245 knots. Further, the contract required that the oil-fuel consumption should not exceed 1 pound per square foot of heating surface, while the result obtained was only 0.86 pound, or 14 percent less than specified. The total consumption for the six hours' run was 68¼ tons, and as the vessel carries in all 148 tons of oil, she has a radius of action of 435 nautical miles at this high speed. At the ordinary cruising speed of 14 knots, however, she will be able to steam 1,500 nautical miles.

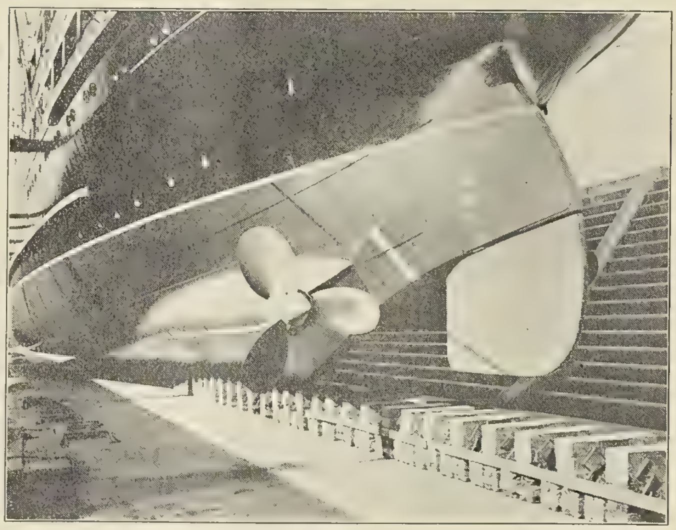
All further tests have proved that the *Mohawk* is well suited for active work. As far as the steam generating plant is concerned we may add that it may be noted that there was an entire absence of smoke, and the steadiness of the oil consumption and of the steam supply was most marked, all of which points to the advantage of oil fuel for high-speed work. Another important advantage was the facility with which full speed was developed; for on her trial trip, seventeen minutes after weighing anchor, the vessel steamed at 34½ knots over the measured mile.

THE PRINCESS CHARLOTTE.

The *Princess Charlotte*, recently built by the Fairfield Shipbuilding & Engineering Company, Ltd., Glasgow, for the Canadian Pacific Railway Company, is a steel twin-screw steamer of the following dimensions:

Length over all	342 feet.
Breadth, molded	42 feet 6 inches.
Depth to shelter deck	26 feet.
Draft	13 feet.
Displacement	2,850 tons.
Indicated horsepower	5,500
Speed	20 knots.
Tonnage, gross	3,600 tons.

The propelling machinery consists of two direct-acting, triple-expansion, surface-condensing engines, each having four inverted cylinders, with four cranks on the Yarrow-Schlick-Tweedy system of balancing. The low-pressure cylinder is at the forward end and next to it is the high pressure. Then comes the intermediate cylinder and the second low pressure is the aftermost. The cylinders are 24, 40, 43½ and 43½ inches in diameter, with a common stroke of 33 inches, and are designed to develop about 5,500 indicated horsepower when driving the ship at 20 knots speed. The valves of the high-pressure and intermediate-cylinders are of the piston type, the others are flat, and all are operated by the Stephenson double-link motion.



STERN OF THE PRINCESS CHARLOTTE, SHOWING THE ANGULAR BOSSING, PROPELLERS AND BALANCED RUDDER.

There is one condenser for each engine, of steel plate with solid-drawn brass tubes. The cooling water for condensing the exhaust steam is circulated through the condensers by two centrifugal pumps, and the condensed steam is withdrawn from the condensers by Weir's patent air pumps. There are two Weir's standard main feed pumps, which draw from the surface feed heaters and discharge into the boilers. For distilling there is one evaporator, capable of producing 20 tons of fresh water per twenty-four hours.

The propellers have three blades each, of manganese bronze, and the bosses are of cast steel. The blades are accurately machined and balanced. There is no outboard shafting, the

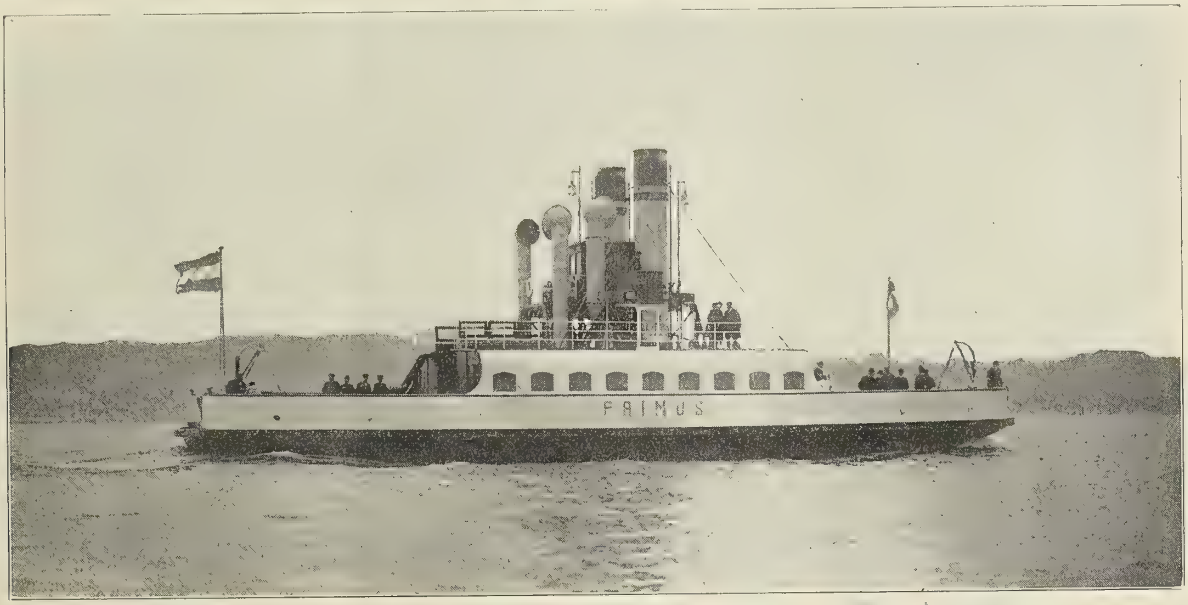
frames of the ship being bossed clear aft to the propeller brackets. The propeller brackets are of cast steel, and are fitted with zinc protectors to prevent corrosion.

The steam generating plant consists of six single-ended steel boilers of the ordinary multitubular type, each working at a pressure of 160 pounds per square inch. They are each 15 feet 6 inches in diameter and 11 feet long, and are arranged in two boiler rooms. All the furnaces are of the Morison suspension type, working under Howden's system of forced draft, air being supplied by three large fans, each driven by an independent inclosed steam engine. The total grate surface of all the boilers is 366 square feet, and the total heating surface 14,640 square feet, giving a ratio of 40 to 1. For the quick disposal of ashes, two See's ash ejectors are fitted, with which it is only necessary to shovel the ashes into a hopper on the stokehold floor, and without further manual labor they are carried through a tube to the ship's side and discharged overboard.

The ship is built to Lloyd's A 1 class for channel service, and has five decks, named in the following order: Orlop, main, shelter, promenade and shade deck. She is fitted with three funnels and two pole masts. Designed for the Canadian Pacific Railroad Company's mail and passenger service between the cities of Vancouver and Victoria, provision has been made to accommodate a large number of passengers. On the promenade deck there is a very broad deck house, occupying nearly the full breadth of the deck, and extending from the shelter bulkhead forward to within a few feet of the stern. Along the sides are staterooms for first class passengers, and the space between these cabins is fitted up as an extensive sitting room. There is a large coach roof on the deck above, which gives this sitting room a lofty and handsome appearance. On the promenade deck aft is the first class smoke room, and on the same deck forward is the observation room, which has large square windows. Above the promenade deck is the shade deck, with officers' rooms and pilot house and the flying bridge. The lifeboats are all stowed on the shade deck. Below the promenade deck is the shelter deck, and the accommodations here are somewhat similar to those on the promenade deck. There are staterooms along the sides, and both forward and aft between the staterooms there is a general saloon. Below the general saloon aft is the first class dining saloon on the main deck, with seating accommodations for 130 passengers. On the main deck forward provision is made for carrying cargo and cattle. The crew and firemen's quarters are on the orlop deck forward, and messing and sleeping accommodation is provided for a large number of waiters and cooks on the orlop deck aft.

The vessel is fitted with a balanced rudder of the builders' own special type, which is worked by a steam tiller controlled from the flying bridge. The anchors are worked by a powerful steam windlass, while a warping capstan aft enables the vessel to be easily handled in harbor.

The speed trials of the *Princess Charlotte* took place on the Firth of Clyde on the 14th of September. These consisted of a progressive trial of four double runs on the measured mile at Skelmorlie, and one six-hour run at full speed. During the six hours at full power, the mean speed obtained was 20½ knots, half of a knot in excess of the guaranteed speed.



ONE OF THE NEW FERRY BOATS FOR KIEL HARBOR.

FERRY BOATS FOR KIEL HARBOR.

BY OUR BERLIN CORRESPONDENT.

Two ferryboats have recently been constructed by the Howaldtswerke to provide an adequate communication between the city of Kiel and the suburb of Gaarden, situated on the opposite bank of the Kiel Strait. These two boats are used for a service carried on at intervals of from four to six minutes; while a third one is provided as a reserve. Both ends of the boats are symmetrical, but the height of the free board at the ends, which is subject to a constant fluctuation, due to the landing of passengers and carriages, is controlled by bridges resting on flat pontoons with out-balanced valves, affording a slightly slanting landing bridge. The boats are provided at each end with a rudder and a screw propeller, and are designed on the type characteristic of ferry steamers. The principal dimensions are as follows:

Length over deck	98 feet 5 inches.
Length between perpendiculars	79 feet ¾ inch.
Breadth over deck	34 feet 5½ inches.
Breadth on waterline	36 feet 6¼ inches.
Depth from upper edge of keel to the side of the deck	14 feet 5¾ inches.
Draft, loaded (with double bottom and bunkers filled)	11 feet 6 inches.
Displacement with above draft	442 tons.
Indicated horsepower	350
Speed	7.5 knots.

The safety of passengers is warranted by all the arrange-

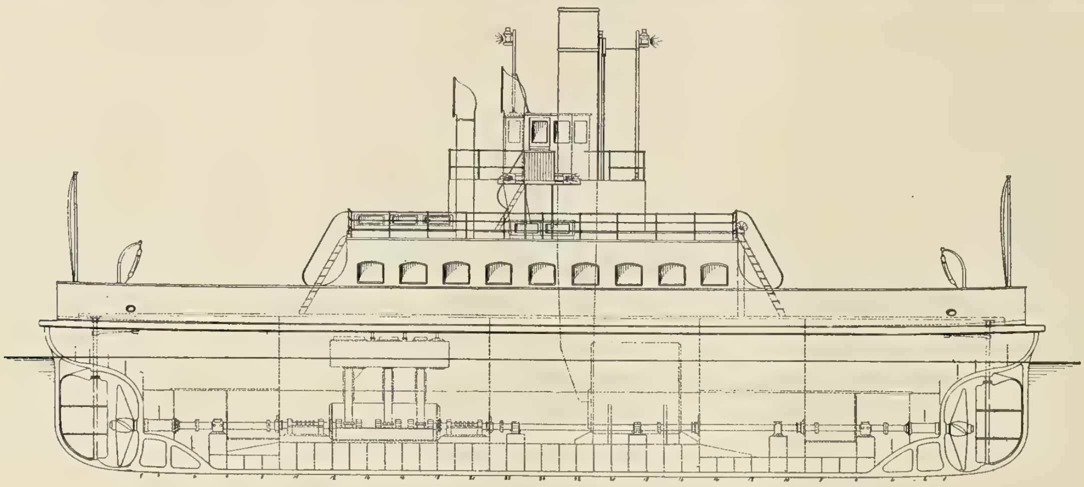
ments usually adopted, in the case of up-to-date passenger steamers, as regards stability, number of watertight bulkheads, height of freeboard, etc. The comparatively large beam is a special feature, the width below the deck decreasing in a continual curve, which gradually passes below the water to the normal form of the frames. This design ensures a form of 'midship frames very favorable for the transverse stability of the boat, while giving the required draft and displacement.

The boats have been built of first-class Siemens-Martin steel, and are designed for conveying 600 passengers of 176 pounds each, or three teams of up to 12 tons each, located behind one another. They are divided into seven watertight compartments by four transverse and two longitudinal bulkheads, which are built watertight as far as the upper deck. The two longitudinal bulkheads limit the coal bunkers, which are situated at the sides of the engine and boiler rooms. The double bottom, consisting of eight watertight compartments, with a total capacity of 45 tons water ballast, extends throughout three-quarters of the length of the boats, and is intended both for storing the boiler feed water and ensuring the stability of the boats when empty. Each tank is provided with a suction pipe leading towards the main engine as well as with air and level tubes. All the various parts of the double bottom are readily accessible through manholes.

A track, 6 feet 6¾ inches in clear width for the carriages to be transported, extends throughout the length of the boat, and is supported by special substantial channel beams supported by a double row of I-beam girders.

The ventilators to the engine and boiler rooms lead through the deck houses at the sides of the track; they are connected with two 21-inch fans for the engine room and two 25-inch fans for the stoke room. Two self-contained steering engines are installed on the platform; on the extensions of these shafts are mounted wheels for steam and hand operation. The steering apparatus is so designed that the rudder, when actually out of use, is automatically stopped from the pilot house, the position lamps being actuated at the same time. In order to protect the stopped rudder a substantial frame, built up by the stern post, is provided; this can also be used for ice-breaking.

Oak planking, 10¼ by 10¼ inches, lined on the outer edge with flat iron, 7/16 inch thick, is fitted around the entire boat, and the hull is reinforced at its ends by special bulkheads within the range of this planking.

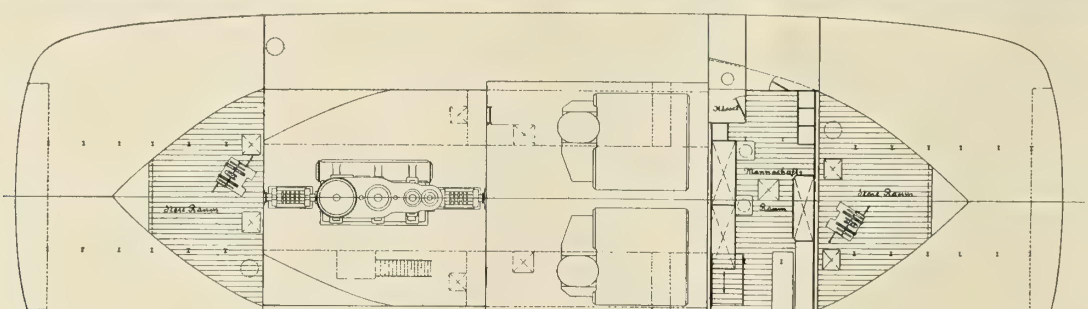


PARTIAL INBOARD PROFILE OF KIEL FERRY, SHOWING ARRANGEMENT OF MACHINERY.

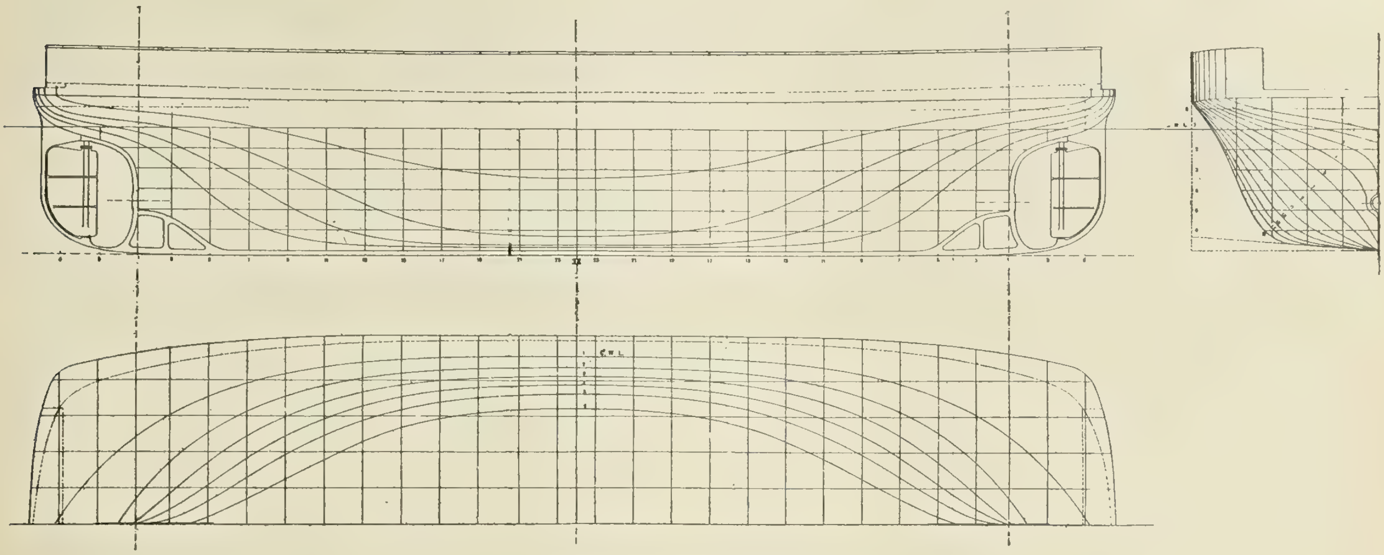
The propelling machinery comprises a triple-expansion engine, with surface condensers, designed for 350 indicated horsepower. The dimensions of the cylinders are:

High pressure	14⅜ inches.
Medium pressure	22⅝ inches.
Low pressure	36⅝ inches.
Stroke	19 11/16 inches.

The three cylinders have been tested at water pressures of 265, 118 and 51 pounds, corresponding to their working pressures; they are covered with felt about 2 inches thick and ballast steel sheets. An "Edward" pump, coupled to the main engine, draws the water from the condenser into the feed-water tank. In addition to a circulating pump, there has been provided an emptying and a feed pump, actuated from the cross-head of the engine. The propeller shaft, 7½ inches in diameter, made of Siemens-Martin steel, extends throughout the length of the boat, and is supported on five bearings, the thickness of the thrust-bearing shaft being 25 percent above the limits prescribed by German Lloyd's. The piping throughout is of copper with soldered bronze flanges. All pipes which have to



LOWER DECK PLAN OF KIEL FERRY.



LINES OF THE NEW KIEL FERRIES.

be protected against heat radiation are coated with insulating material. The exhaust from all the auxiliaries can be led either overboard or into the condenser.

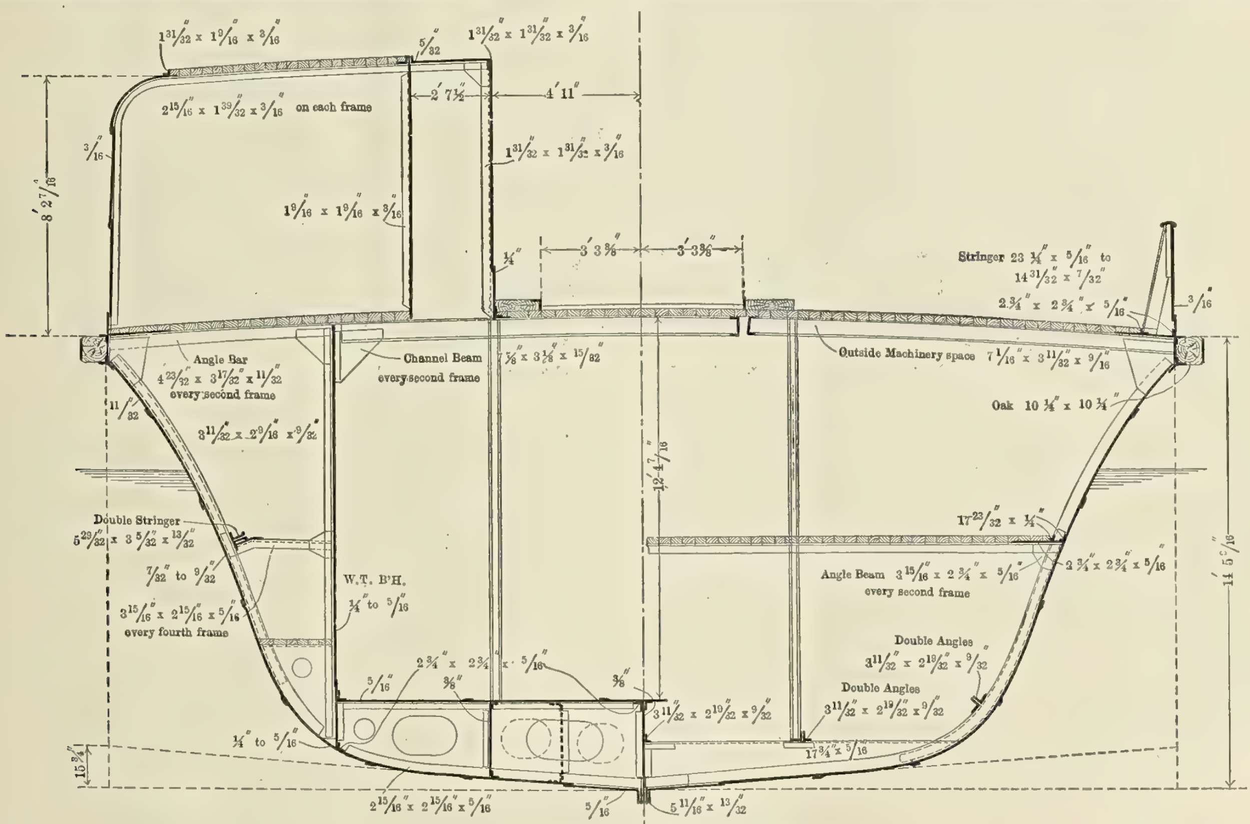
The dimensions of the two propellers (which are four-bladed cast steel) are as follows:

Diameter	8 feet 2½ inches.
Projected area..................	30.67 square feet.
Pitch	9 feet 3 inches.
Slip	.213

In designing the propellers it was necessary to make provision for starting and stopping the boats rapidly.

grate area of 40 to 1. The working steam pressure is 191 pounds per square inch, and the test pressure 265 pounds. The boilers are lined with asbestos felt and a sleeve of zinc-plated sheet iron. A "Worthington" pump, with a 4½-inch steam cylinder, a 2¾-inch water cylinder and a 3 15/16-inch stroke, is installed, which can be connected to the double bottom, the condenser, the air pump cistern or boilers, while being used as well for feeding the boilers and emptying and working in connection with washing the deck.

The electric current for lighting the boats is generated by a continuous-current shunt dynamo, at a tension of 100 volts,



MIDSHIP SECTION OF KIEL FERRY, SHOWING SCANTLINGS.

Steam is derived from two cylindrical return tube boilers, each 10 feet 7½ inches in diameter and 10 feet 5 inches long. Their total heating surface is 1,391 square feet, and their grate surface 35 square feet, making a ratio of heating surface to

operated by a compound engine with cylinders 5½ and 9 7/16 inches in diameter, operating at 350 revolutions per minute. Provision has been made in the engine room for installing a fire engine for harbor service.

During the trial runs, the first of these boats attained a speed of 8.16 knots with 104 revolutions per minute and 312.6 indicated horsepower, thus reaching at reduced power a speed nearly three-quarters of a knot above the normal figure. The coal consumption was found to be 1.54 pounds per indicated (metric) horsepower, as against the guaranteed figure of 1.65 pounds.

A SEA-GOING LIFE SAVER.

BY C. A. M'ALLISTER.

The new revenue cutter *Snohomish*, new en route to the Pacific Coast from Wilmington, Del., where she was constructed, is the first sea-going craft ever built exclusively for the purpose of saving life. In the building of this vessel the United States Government has furnished another example of its willingness and desire to aid humanitarian enterprises looking towards the welfare and safety of its people afloat as well as ashore.

The origin of this vessel may be traced directly to the loss of the steamship *Valencia* on Vancouver Island, B. C., which occurred on the night of Jan. 22, 1906, resulting in a loss of 136 lives. This disaster was the culmination of a number of shipwrecks in that vicinity, the seriousness of which can be judged from the statement that during the past fifty years nearly 700 persons have lost their lives in these waters. The public discussion and interest aroused by the loss of the ill-fated *Valencia* resulted in the appropriation by Congress of $200,000 (£41,090) for the construction of "an ocean-going tug for the North Pacific Coast."

This has materialized in the *Snohomish,* a staunchly built and powerful sea-going tug, capable of withstanding any sea which may arise and any gale that may blow. The purpose of this sketch is more to describe some of the distinctive life-saving equipment of the craft than to expatiate on the details of her construction, yet it is well to state that she is a vessel of 795 tons displacement, having an over-all length of 152 feet, a beam of 29 feet, a depth of 17 feet 6 inches, and a normal draft of 12 feet 4½ inches. Her machinery consists of one Scotch boiler and one Babcock & Wilcox water-tube boiler, and a triple-expansion engine which developed, during a 4-hour test an average of 1,372 horsepower, with a resultant speed of 13.65 knots, a performance which can easily be bettered in case of emergency. Her propeller is 11 feet in diameter with a pitch of 11 feet.

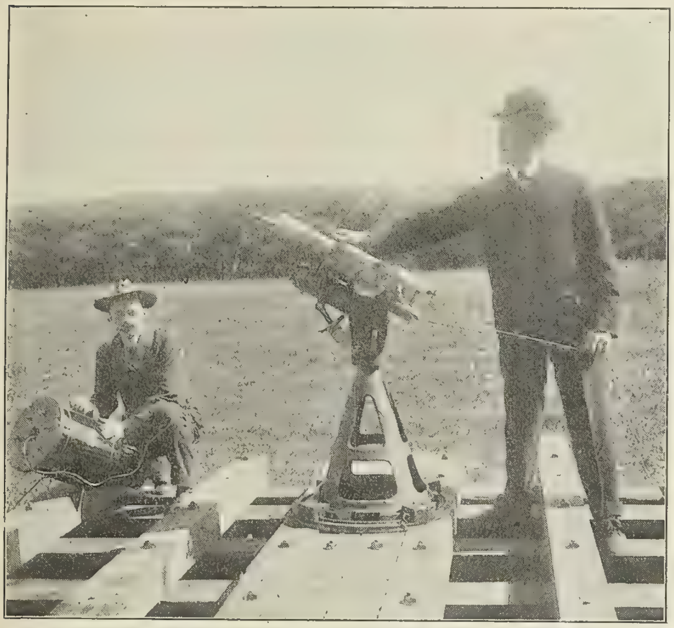
THE SPENCER-MILLER LIFE-SAVING APPARATUS IN OPERATION.

The vessel, it will therefore be seen, is of ample size and of proper design and power to fulfill her mission of saving lives at sea. For this purpose the following special equipment has been fitted:

1. Breeches buoy apparatus for removing shipwrecked persons from wrecks which are inaccessible to lifeboats.
2. Line-throwing guns to be used in connection with the above apparatus.
3. Two self-bailing and self-righting lifeboats.
4. Life raft.
5. Complete equipment of life buoys and life preservers.
6. Wireless telegraph.
7. Two powerful searchlights.
8. Telephotos or night-signaling apparatus.
9. Fire-extinguishing apparatus.
10. Wrecking pump and suction hose for pumping out vessels.

By far the most novel and interesting piece of the above special apparatus is the breeches buoy device for rescuing shipwrecked people when the conditions are such as to preclude their being taken off wrecks by the ordinary methods. This problem is so much akin to the coaling of ships at sea by means of what may be termed a uniform tension cableway, that it was but natural to adopt the apparatus, the utility of which has been so successfully demonstrated in connection with coaling naval vessels at sea from colliers. This apparatus consists in general of a large drum on which the cable is coiled: this drum being operated by a double engine, the valve gear of which is so designed as to admit steam to the engines and take in the slack of the cableway when the vessels roll together and pay out cable when they roll away from each other; thus maintaining, at all times, a normal, uniform tension in the cableway between the two vessels. Consequently a contract was made with the one concern in this country which has made this difficult matter a success, the Lidgerwood Manufacturing Company, New York.

The modus operandi, as practiced during trials of the apparatus, and as will undoubtedly be adopted under actual service conditions, will be to anchor the vessel at a safe distance off shore from the wreck and shoot a small line over the ship in distress from the line-throwing gun. This line will be of sufficient strength to allow the crew on the wreck to haul aboard the block and whip. A tally board will be fastened to the block, upon which will be printed in several



ONE OF THE HALL LIFE-SAVING GUNS USED ON THE SNOHOMISH.

of the more important languages full directions as to how it is to be secured. Then the hawser or cableway will be sent on board by means of the whip, to which another tally board is tied, giving directions as to how it is to be secured. After the cableway has been fastened as directed, then by means of the whip, the breeches buoy, suspended from a traveler block, will be hauled off. The passengers and crew will then be taken off the wreck; one at a time if conditions permit, but if the vessel shows signs of breaking up, then two persons may be transferred at one trip. The life-saving guns used on the *Snohomish* are of the Hall improved type, built by the Lackawanna Marine Engine Works, Newburgh, N. Y. This gun is of the breech-loading type, mounted in such a way that the recoil from the discharge is taken up entirely by the mount itself, so that the gun can be accurately fired from any spot without being fastened securely to the vessel.

In the event that the sea will permit the transfer to be made by the use of boats, then the two-self-bailing and self-righting lifeboats will be lowered, and the rescue of those on the distressed vessel more rapidly effected. These lifeboats are of the most modern, self-bailing and self-righting metallic type, 24 feet long, and of the design which has proved most seaworthy and best adapted for general life-saving purposes under varying conditions of sea and location of wrecks.

In addition to these large lifeboats, a small, light *Otter* boat is provided. This is of the type used by the sealers and sea-otter hunters of the North Pacific and Behring Sea, and experience has demonstrated their great utility in rough water. They are light and buoyant as cork, and easily handled by two men. This boat could be used in running a light line to a distressed vessel, or even in the assistance of rescuing those on board. Circumstances might arise where a raft could be used to advantage, and for that purpose a metallic life-raft is at hand fully equipped for any emergency.

It is expected that much of the information as to disasters at sea or wrecks on shore will come to the *Snohomish* through the medium of the wireless telegraph, and as the set installed on the vessel is of the latest design, 1 kilowatt in capacity, with a sending range of 100 to 150 miles, and capable of receiving messages from a distance of 800 to 1,000 miles, the added facilities afforded by this equipment can be well appreciated.

The two large searchlights will be of great assistance during night work; and for communication with those on the wreck, or in the life-boats away from the *Snohomish* at such times, the "Ardois" night-signaling set will be of especial advantage, as the ordinary code is well known to nearly all men who follow the sea in the position of a ship's officer.

It will be seen from the foregoing sketch that every endeavor has been made to provide the most seaworthy vessel possible of such a size as to be able to withstand all conditions of sea and storm, and yet capable of being readily handled when maneuvering about a wreck, fully equipped with all known apparatus and appliances for facilitating the rescue of those who may be shipwrecked and in distress along the dangerous shore of the North Pacific Coast.

THE WHIRLING OF SHAFTS.

It is quite possible for a shaft designed to transmit a given twisting moment to be entirely satisfactory when running at a comparatively low speed, and yet to suffer serious damage when it is run at a high speed, transmitting little or no twisting moment. Any slight initial bending of the shaft increases markedly as the speed increases until when a certain critical speed is reached the shaft breaks. This critical speed may be termed the "whirling" speed. In ordinary shop shafting whirling speeds are never or rarely reached. The introduction of the steam turbine has, however, been accompanied by such high shaft speeds that it becomes imperative to consider whirling in designing the shafting. Even if the shaft is perfectly true and balanced, an initial deflection, however slight, is quite sufficient to set up whirling, and if we run the shaft in the neighborhood of the whirling speed serious damage is invariably the consequence. It is the purpose of this article to give an account of the several formulæ from which whirling speed can be ascertained.

Consider a shaft with bearings at A and B (Fig. 1) rotating at an angular speed ω. Suppose the line $A\,B$ denotes the initial

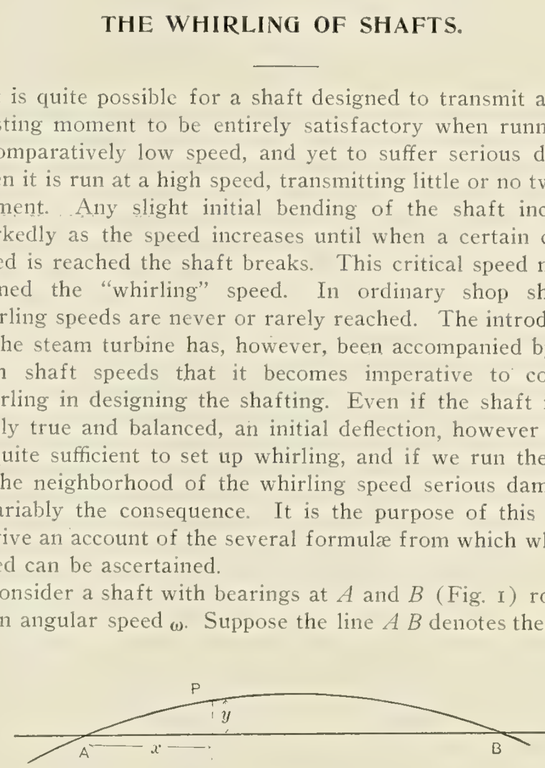


FIG. 1.

position of the shaft, and the curved line APB the disturbed position when running at speed ω. Let the co-ordinates of any point P in the shaft be x, y, referred to the end bearing A as origin. If σ denotes the weight per running foot of the shaft, then the disturbing force on the shaft at P is $\frac{\sigma}{g}\,\omega^2\,y$; where g is the acceleration due to gravity. When equilibrium is reached the disturbing force is equal to the controlling force (the elastic force tending to restore the shaft to its original shape). The shaft is then under flexure, as though it were loaded with a load distributed as and equal in magnitude to the controlling force. If, therefore, M denotes the bending moment at the section of the shaft at P, we have (since the second differentiation of the bending moment curve gives the load curve) that

$$\frac{d^2M}{d\,x^2} = \text{controlling force} = \frac{\sigma}{g}\,\omega^2 y.$$

Also in any loaded beam

$$M = E\;I\,\frac{d^2y}{d\,x^2}$$

where E = coefficient of elasticity of the material and I =

moment of inertia of the section of the beam; whence it follows that

$$\frac{d^2M}{d\,x^2} = E\ I\ \frac{d^4y}{d\,x^4} = \frac{\sigma}{g}\ \omega^2 y.$$

or

$$\frac{d^4y}{d\,x^4} = \frac{\sigma}{g\ E\ I}\ \omega^2 y = m^4 y;\ \text{where } m = \sqrt[4]{\frac{\sigma\,\omega^2}{g\ E\ I}}$$

The solution of this differential equation is given by

$y = A \cos h\ m\ x + B \sin h\ m\ x + C \cos m\ x + D \sin m\ x\ (\alpha)$

To obtain the constants A. B. C. D. we must apply the terminal conditions.

Case (1). Suppose the shaft be not contained at the bearings, that is, the bending moment at each end of the shaft at the bearings is zero. We have then that, when $x = o,\ y = o$ and

$$M = E\ I\ \frac{d^2y}{d\,x^2} = o,$$

and when $x = l$ (l being the length of the shaft between the bearings) then $y = o$, and

$$M = E\ I\ \frac{d^2y}{d\,x^2} = o.$$

It then follows that

$$\frac{\sigma}{g} \times \frac{\omega^2}{E\ I}\ l^4 = \pi^4 \ldots\ldots\ldots\ldots\ldots (\beta)$$

If N = revolutions of shaft per minute corresponding to whirling.
w = weight per cubic foot of the material (480 pounds for steel).
d_1 and d_2 = internal and external diameters in inches.
E = 29×10^6 pounds.
l = span in feet.

Then (β) reduces to

$$N = \frac{33{,}000\ \sqrt{d_1^2 + d_2^2}}{l^2}$$

Case (2). Suppose the shaft be fixed in direction at one end, but free at the other. The constants *A. B. C. D.* in the equation (α) then vary, and the formula for the whirling speed then becomes

$$N = \frac{51{,}000\ \sqrt{d_1^2 + d_2^2}}{l^2}$$

Case (3). If the shaft be fixed in direction at each end, *e. g.*, a shaft in very long and very rigid bearings, we get

$$N = \frac{75{,}000\ \sqrt{d_1^2 + d_2^2}}{l^2}$$

It is seen that the whirling speed of a shaft under different conditions of constraint at the bearings is represented by

$$N = \frac{K\ \sqrt{d_1^2 + d_2^2}}{l^2}$$

where K has a value ranging from 33,000 to 75,000.

If $d_1 = o$ we get a solid shaft, and then

$$N = \frac{K\,d}{l^2}$$

where d = diameter of the solid shaft; that is, in the case of a *solid shaft the whirling speed varies directly as the diameter and inversely as the square of the length of the shaft between the bearings.*

Whirling cannot be prevented if we approach the whirling speed. We must so design our shafting, either by alteration in the diameter or in the span that the maximum speed at which the shaft is to run, is well below the whirling speed.

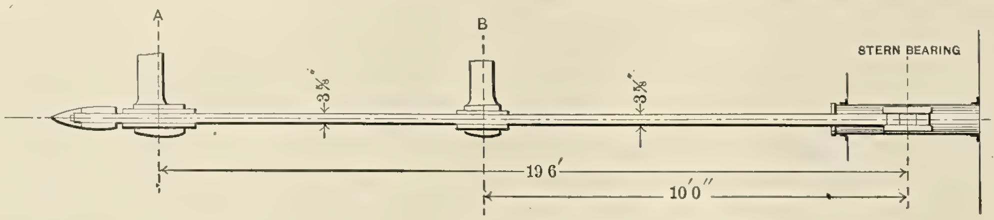


FIG. 2.

It is seen that the assumptions on which our formulæ are based do not include the effect of several bearings in association with a continuous shaft, the effect of the thrust of the screw nor that of the overhanging propeller in propeller shafting. The general effect of these is to reduce the whirling speed.

As an example of the application of the formulæ let us consider the shafting shown in Fig. 2.

The designed revolutions were 1,300, the span from the middle of the stern tube to the center of the bearing at the shaft bracket at A was 19.6 feet, the diameter of the shaft (solid) was 3⅝ inches. Using the formula

$$N = \frac{51{,}000\ \sqrt{d_1^2 + d_2^2}}{l^2}$$

$d_1 = o,\ d_2 = 3⅝$ inches; $l = 19.6$.

Hence, $N = 480$ revolutions per minute. This would never do, as we should have to pass through this speed to reach our speed of 1,300 revolutions per minute.

The obvious way out of the difficulty is to place another support between the stern tube and extreme bracket A. This can be done by placing the bracket B at 10 feet from the center of the stern tube, thus dividing the original span into two spans of 9.6 feet and 10 feet, respectively. Taking the larger span, 10 feet, as giving the worst case, we have the whirling speed corresponding to this span as given by the formula

$$N = \frac{51{,}000\ \sqrt{d_1^2 + d_2^2}}{l^2}$$

where $d_1 = o,\ d_2 = 3⅝$ and l now equals 10. The whirling speed is now

$$\frac{51{,}000 \times (3⅝)}{100} = 1{,}850 \text{ revolutions per minute.}$$

This is well above our designed speed, so that the introduction of the additional shaft bracket B at about midway between the stern tube and the extreme bracket A keeps our designed speed well below the dangerous whirling speed.

G. R.

THE FRENCH ARMORED CRUISER ERNEST RENAN.

BY J. G. PELTIER.

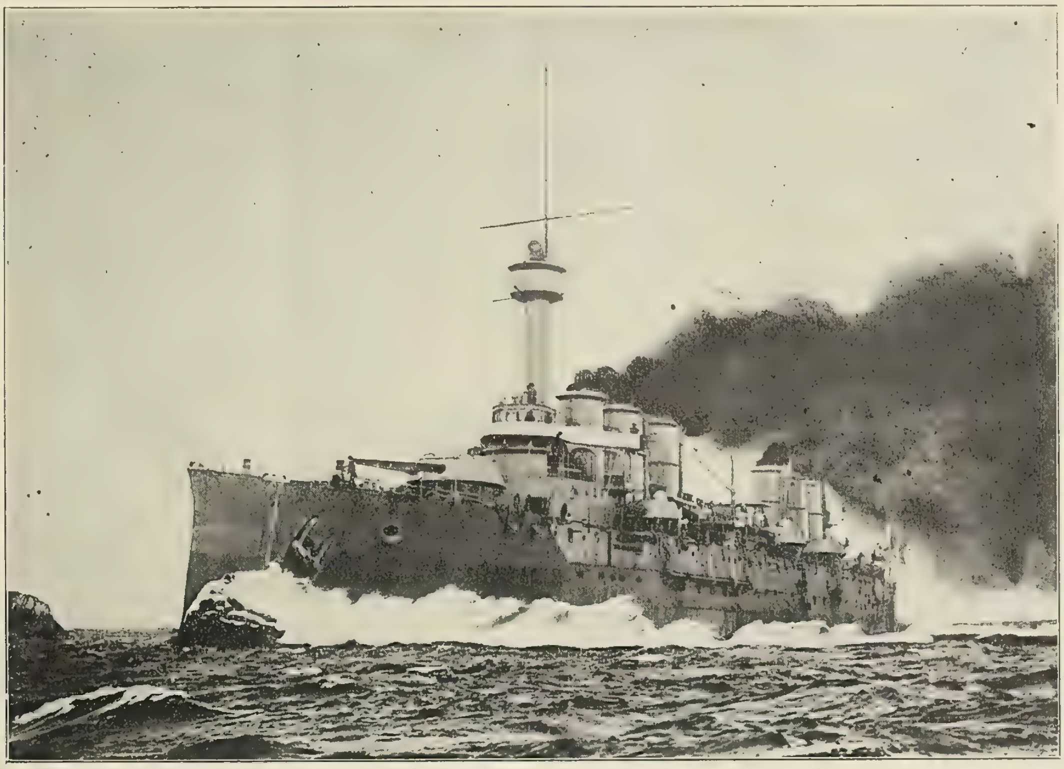
Although authorized in the French naval programme of 1900 and contracted for in August, 1903, yet, due to the many changes in design made by the Admiralty, the *Ernest Renan,* the first of the 23-knot French cruisers, was not completed until April, 1908, and her official trials were not carried out until the latter part of the same year. The *Ernest Renan* is 515 feet 2 inches long on the waterline, with a beam of 70 feet 1 inch, and, at a draft of 26 feet 10 inches, displaces 13,644 tons. Three triple-expansion engines, aggregating 37,000 horsepower, were designed to drive the ship at a speed of 23 knots.

The hull is built of the highest quality mild steel, and there is no metal keel, simply a docking keel of teak and two bilge keels, extending for about three-fourths of the ship's length amidships. The stem is of forged steel and the stern frame of cast steel. From the bottom of the ship to the lower protective deck the hull is divided into numerous main compartments, many of which are sub-divided into smaller watertight compartments. The double bottom extends to the protective deck. The shell plating is 11/16 inch maximum thickness below the waterline, and 13/32 inch above the waterline. The plates are worked according to the double-clincher, double-garboard and two-strake system.

As is the custom on all French warships the armor is arranged according to the "tranche cellulaire de protection" system, which consists of side armor and lower and upper protective decks. The highest point of the lower protective deck is a little above the load waterline. At the sides it is 4 feet 7 inches below this level. It is built of 1.4-inch mild steel plates, protected by 1.8-inch nickel steel armor on the flat and 2.6-inch nickel-steel armor on the slopes. The upper protective, or splinter, deck is at the height of the upper edge of the second strake of side armor. It is built of steel plates from 1.4 inches to 13/32 inch thick.

There are three strakes of side armor, the first and second of which extend from the stem to within a few feet of the stern, terminating at an athwartship armored bulkhead. The belt extends 4 feet 7 inches below the normal waterline and 17 feet 1 inch above the waterline forward and 7 feet 7 inches above it aft. The first strake is 6.7 inches thick forward reduced to 4 inches aft. The second strake is 5 inches thick forward reduced to 3.6 inches aft, while the third strake extends from the stem 122 feet aft, or up to the casemates of the forward 6.5-inch guns; thus it will be seen that there is ample protection for the bow of the ship. The athwartship armored bulkheads extend from the outside plating of the casemates to the 7.6-inch turrets, and as an additional protection a cofferdam extends the entire length of the ship at the waterline.

With the exception of the spardeck, all decks are clear from all the ordinary auxiliary apparatus which was formerly found on all French warships. This is worthy of note, because it shows the new policy inaugurated by the Admiralty. Between decks the vessel is roomy and well fitted out.



THE ERNEST RENAN AT FULL SPEED.

The armament consists of four 7.6-inch guns mounted in pairs in turrets, one forward and one aft of the superstructure, each having a total arc of fire of 228 degrees. There are twelve 6.4-inch guns, eight of which are mounted single in turrets on the spardeck, four on each side, the remaining 6.4-inch guns being located in four casemates, two forward and two aft. The secondary armament consists of sixteen 2.6-inch rapid-fire guns, of which twelve are located in the broadside battery and the remainder on the bridges. There are also four 3-pounder guns and two 18-inch submerged torpedo tubes. The fore-and-aft fire consists of two 7.6-inch guns and six 6.4-inch guns, while for the broadside fire four 7.6-inch and six 6.4-inch guns are available. The 7.6-inch turrets are protected by 8-inch armor and the barbettes with 5-inch armor, while the smaller turrets are protected by 5.5-inch armor. The casemates are protected by 5-inch armor.

The cruiser is propelled by three main engines of the four-cylinder triple-expansion type, located in three watertight compartments amidships. The cylinder diameters are: high pressure, 45 inches; intermediate, 68 inches; low pressure, 78

inches. The stroke is 42 inches and the revolutions per minute at full speed 133. The order of the cylinders from the forward to the after end is low pressure, high pressure, intermediate pressure and low pressure. There are three reversing engines, one of the usual type, another of a special type, and a third operated with oil. Each engine has two separate condensers with auxiliary apparatus in a special watertight compartment, while between the condensers are the thrust blocks.

Steam is furnished by forty-two Niclausse watertube boilers, located in watertight compartments containing batteries of eight each. Part of the boilers are forward and part aft of the main engines. The products of combustion escape by means of six funnels, 91 feet high above the grate bars. The boilers are 7 feet 6 inches long, containing a total of 14,526 tubes, the upper ones being 2 15/16 inches inside diameter and the lower ones 3 1/16 inches inside diameter. The working steam pressure is 299 pounds per square inch, the total grate area 2,780 square feet, and the total heating surface 84,620 square feet. The boiler rooms are supplied with fresh air by electric fans and by steam-driven fans for forced draft. The ashes are removed by means of electric winches.

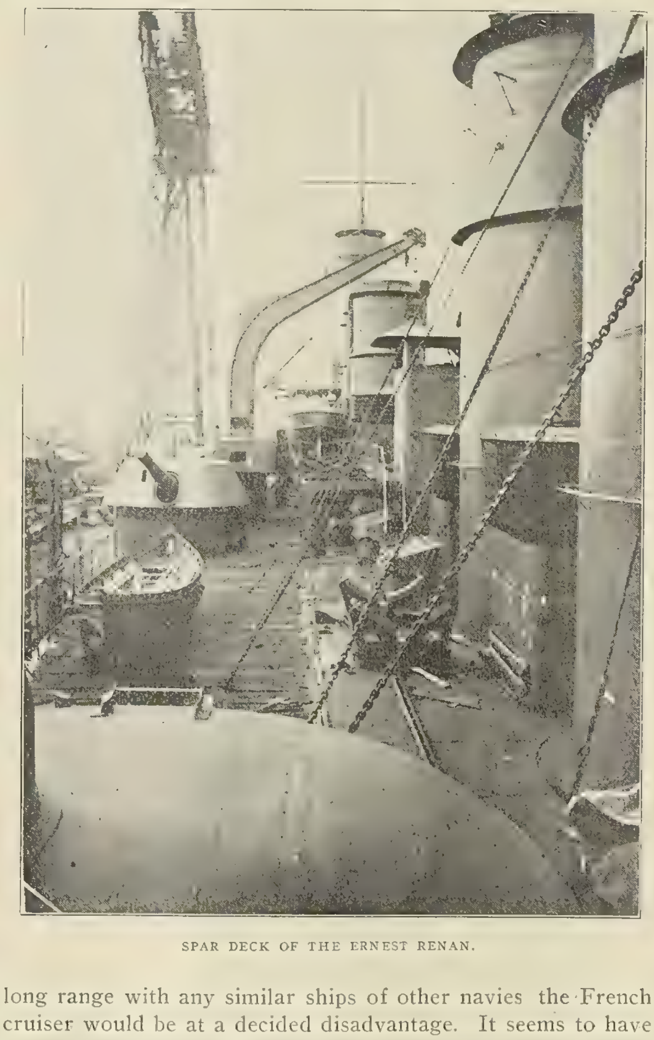
QUARTER DECK OF THE ERNEST RENAN.

The total capacity of the coal bunkers is 2,300 tons, the normal supply being 1,524 tons, the steaming radii at 10 knots under these conditions being, respectively, 12,000 and 7,500 miles. At full speed the steaming radii are 1,650 and 1,028 miles, respectively.

The auxiliary machinery includes four dynamos, located in two separate watertight compartments on the lower protective deck. These dynamos operate at 110 volts, and have a capacity of 1,200 amperes each. All apparatus, except that requiring excessive power, is driven by electricity. The turrets, ammunition hoists, ventilating fans, with the exception of the forced draft blowers, are all electrically driven. There is a complete refrigerating plant for the magazines, which are close to the boiler or engine rooms. The distilling apparatus has a capacity for 35,000 gallons of fresh water per day.

If the *Ernest Renan* is compared with similar ships of the leading naval powers which were designed or laid down at the same time, it is easily seen that in the matter of armored protection she is superior to any other ships. As far as thickness of armor is concerned, assuming that the quality is the same on all the ships, the *Warrior* and *Minotaur* of the English navy have a slight superiority. The German type, although protected to an extreme height amidships, has no efficient protection fore and aft. The *Tennessee* of the United States navy has a better protected surface, but it is to be regretted that she has not been given better protection forward, as this will cause a certain inferiority in an engagement, because the bow is a vital part of a ship which is built for speed. It is distinctive of the French type that the bow of the ship is given ample protection far in advance of that provided in any other navy.

In the matter of armament this cruiser shows a great inferiority in caliber. It is certain that in an engagement at long range with any similar ships of other navies the French cruiser would be at a decided disadvantage. It seems to have been the rule in the French navy, at least up to the present time, that in a ship of certain tonnage the better part of the displacement is utilized for speed, the second consideration being armored protection, while the armament of the ship is the last consideration. French warships have been consistently developed to fight among themselves, but not to fight with similar ships of other navies. The caliber of the small guns is the smallest used in any navy in the world.



SPAR DECK OF THE ERNEST RENAN.

On her full-speed trials the *Ernest Renan* exceeded her

designed speed by nearly a knot and a half. Further details of the trials are shown in the table, which show that the engineering work, as carried out by the builders of the vessel, the *Chantiers de l'Atlantique,* has been most successful.

TRIALS OF THE FRENCH ARMORED CRUISER ERNEST RENAN.

	Number of Boilers.	Grate Surface Sq. Ft.	I.H.P.	Pounds Coal per I.H.P. per Hour.	Pounds Coal per Sq. Ft., Grate Area.	Speed, Knots.
6 Hour Trial at Reduced Speed, Sept. 4, 1908.						
Official Trial.......	6	417	3,336	1.45	11.61	8.59
Contract Figures....	Not	Specified.	3,250	1.32 to 1.54	......	Not Specified.
24-Hour Run at Normal Speed, Aug. 21-22, 1908.						
Official Trial.......	42	2,680	22,560	1.53	12.86	21 23
Contract Figures....	42	2,680	21,600	1.43 to 1.65	......	Not. Specified.
10-Hour Full Power Run, Sept. 8, 1908.						
Builder's Trial......	42	2,680	37,772	Not Determined.		24.44
Contract Figures....	42	2,680	36,000	Not Specified.	24.58 to 25.65	23.00

THE TOTAL HEAT OF SATURATED STEAM.*

BY DR. HARVEY N. DAVIS.

For many years Regnault's classic formula, now sixty-one years old, which gives as the total heat of saturated steam

$$H = 1091.7 + 0.305\ (t - 32)\ B.\ T.\ U.,$$

has been exclusively used by engineers in America, yet the remark is becoming common that such and such a method cannot be used because of the well-known errors in the steam table. It is therefore fortunate that, at least in the range from 32 to 212 degrees, physicists have recently provided a considerable number of good observations of the total heat of saturated steam apparently not noticed by the makers of our steam tables. It is equally unfortunate that, in all these years, there seems to have been not a single new observation above the boiling point. It is the purpose of this paper to show that certain observations recently made for very different purposes can be combined to give a better set of values of H above 212 degrees than do Regnault's direct measurements, and to propose a new formula for the range from 212 to 400 degrees, the accuracy of which is believed to be something like 0.1 percent. If these results are correct, Regnault's formula is too high by more than 18 B. T. U., or 1.7 percent at 32 degrees; too low by 6 B. T. U., or 0.5 percent at 275 degrees, and too high again above 380 degrees, the error increasing rapidly at high temperatures.

Some years ago attempts were made to determine the variation of the specific heat of superheated steam with pressure and temperature by means of throttling or wire-drawing experiments. These attempts failed because, as the observers themselves pointed out, the necessary computations were extremely sensitive to small errors in the assumed values of the total heat of saturated steam. Under unfavorable circumstances, an error of 0.1 percent in one of the values in the steam tables might make a difference of from 3 to 5 percent in C_p. It is then evident that, knowing C_p independently, one could reverse the process by which they tried to get it, and compute all the total heats in terms of any one by a method as insensitive to errors in assumed data as the other was sensitive.

Fortunately, since these experiments, C_p has been determined independently and directly by Knoblauch and Jakob, of Munich, and by Thomas, of Cornell, and the accuracy attained by them is sufficient to make worth while such a recomputation of the wire-drawing experiments. In this work, Knoblauch's values of C_p will be used rather than Thomas'.

The throttling experiments used are those of Grindley, in England, in 1900; of Griessmann, in Germany, in 1904, and of Peake, in England, in 1905. The recomputation of these throttling experiments, considered in connection with Knoblauch's determination of the specific heat of superheated steam, lead to a new formula for the total heat of saturated steam, namely:

$$H = H_{212} + 0.3745\ (t - 212) - 0.000550\ (t - 212)^2.$$

The best available value of H_{212} seems to be 1150.3 mean B. T. U., which is the average of the values of Henning and of Joly. The total heat equation becomes

$$H = 1150.3 + 0.3745\ (t - 212) - 0.000550\ (t - 212)^2.$$

The range of this formula is from 212 to about 400 degrees F. The greatest error in Regnault's formula in this range is 6 B. T. U., at 275 degrees F.; but if Regnault's formula is extrapolated to higher temperatures, the error in it increases very rapidly. Below 212 degrees there is an abundance of modern data to show that Regnault's formula runs high, the error reaching 18 B. T. U. at 32 degrees.

Recomputed values of the specific volume of saturated steam differ from the standard values by 101 cubic feet, or 3 percent at 32 degrees, and by about 1 percent in the opposite direction at 275 degrees. Computed values of C_p at saturation agree strikingly with Knoblauch's values, and give additional confirmation to a conclusion already reached that of the three available sets of C_p values, Knoblauch's, Thomas' and Heck's, Knoblauch's is most deserving of confidence.

A steam table based on these new values will presently be published under the joint authorship of Prof. Lionel S. Marks and the present writer.

* Abstracted from a paper presented at the December, 1908, meeting of the American Society of Mechanical Engineers, New York.

A NEW ORIENT LINER.

The Fairfield Shipbuilding & Engineering Company, Ltd., recently launched the twin-screw steamer *Otway* for the Australian mail and passenger service of the Orient Steam Navigation Company, Ltd. The *Otway* is a vessel of about 12,000 tons gross, with the following dimensions: Length, 552 feet; breadth, 63 feet 3 inches; depth, 46 feet. She is divided into ten watertight compartments, and has seven decks, viz.: boat, promenade, shelter, upper, main, lower and orlop. Accommodations are provided for 280 first class passengers, 115 second class, and 700 third class and emigrants. The vessel is schooner-rigged with two pole masts; has a straight stem and elliptical stern; is fitted with a balanced rudder and an auxiliary rudder for Suez Canal requirements.

At the forward end of the boat deck a large deck house has been built to accommodate the navigating officers, with the chart house and navigating bridge above. On the same deck amidships is the wireless telegraph station, the remainder of the deck being given up entirely as a promenade for first class passengers and the housing of the boats.

At the forward end of the promenade deck is situated the lounge and first class entrance, which has been tastefully decorated in Italian walnut. An elevator is provided to carry passengers from this entrance to the various decks and saloons. Adjoining this room is the first class music room and library, also finished in Italian walnut; the bay windows in this room are a special feature, enabling the passengers to have a full view of the promenade. Amidships, on the promenade deck, is a large deck house, which encloses the first

class staterooms. At the after end of this house is the first class smoking room, which is finished in Austrian wainscot with furniture to match. Opening from the smoke room at the after end is a veranda, which can be used as a deck lounge in fair weather. Around the deck houses is a broad and spacious promenade, under cover of the boat deck, and between the deck houses a large area of the deck has been kept clear for sports. Aft of and isolated from the first class is a covered promenade for third class.

The shelter deck forward of the bridge bulkhead is reserved for working the vessel and handling the cargo, and is fitted with powerful windlasses, capstans, winches and cranes. Abaft this bulkhead for a distance of about 60 feet the ship's side plating extends to the promenade deck, and continues aft into a deck house 160 feet long with a promenade on either side. At the forward end cabins-de-luxe or en suite rooms have been arranged. Immediately abaft these cabins, and in the center, is a large well over the first class dining saloon with special cabins on each side. The remainder of this house is fitted up with two-berth staterooms.

Continuing aft is the promenade for second class passengers, on which is situated the second class smoke room and music room and stairway leading down to second class accommodations below. At the after end, and divided from the second class by a barrier, is a comfortable music room and smoke room for the third class, with access to their living quarters.

The forward end of the upper deck is reserved for the wash-places and mess rooms for steerage, firemen and seamen. Abaft of this, and extending to the grand staircase, are first class staterooms.

The first class dining saloon adjoins the main staircase, and is a magnificent hall extending in breadth from side to side of the ship, and measures over 50 feet in length. The saloon is finished in Italian walnut, and small tables are used. Overhead in the center of the saloon is an immense rectangular well, tastefully decorated, forming a gallery on the deck above. In the center of the ship, immediately aft of the first class dining saloon and forward of the second class dining saloon, are the galleys, pantries, sculleries, larder, bakery and confectionery. The second class dining saloon is 52 feet long by 63 feet wide, capable of seating 151 persons at one time. Aft of this are the second class staterooms, fitted up on the Bibby system, giving light to the inside rooms. At the after end of the upper deck are the third class accommodations.

The fore end of the main deck is reserved for the berths of the seamen and firemen. Around the main staircase are arranged staterooms on the Bibby system for first and second class passengers, with a children's saloon having seating accommodations for twenty.

The vessel will be propelled by twin screws, each driven by an independent set of quadruple expansion engines, balanced on the Yarrow, Schlick & Tweedy system. The high-pressure and the first intermediate-pressure cylinders have piston valves and the larger cylinders have ordinary flat slide valves, all worked by Stephenson's link motion, and controlled by steam reversing gear of the direct-acting type. The shafting is of hydraulic forged Siemens-Martin mild steel, each crank shaft being in four sections. The propellers have three bronze blades, fixed to cast-steel bosses.

A very complete installation of auxiliary machinery in duplicate will be fitted, comprising a complete electric plant, the latest improved steam steering gear, including Brown Bros. (Edinburgh) patent hydraulic telemotor, ventilating fans, telegraph, telephone, etc.

Steam will be supplied by four double-ended and two single-ended Scotch boilers, designed for a working pressure of 215 pounds per square inch. Howden's system of forced draft is fitted to all the boilers, the necessary air pressure being sustained by five large motor-driven fans.

A separate compartment forward of the boiler rooms contains the refrigerating installation, consisting of three different machines, the two larger machines on the dry-air principle, for dealing with the cargo holds; and the third machine, on the carbonic anhydride system, for cooling the stores required for ship's use.

THRUST AND JOURNAL BEARINGS.

A perfectly lubricated journal bearing will maintain its lubrication and carry a load up to 500 pounds per square inch with a comparatively low friction loss. On the other hand, a thrust bearing will not support continuously more than 60 or 70 pounds per square inch, and has a very high friction loss. The reason for this difference is that the form of the bearing in the one case is well adapted to maintain lubrication, while in the other it is not.

Since the amount of work lost in friction depends upon the nature of the two surfaces in contact, it, of course, is evident that a bearing which, from its construction, tends to maintain a film of lubricating oil between the two metallic surfaces will be more efficient than one in which there is no such tendency, and, consequently, a metal-to-metal contact. In a journal bearing the oil is carried by the rotation of the shaft from the point of no pressure in the bearing, and is formed into a wedge, continually forcing apart the shaft and the bearing. In a thrust bearing of the usual type, consisting of one or more collars on the shaft bearing against corresponding collars on the thrust block, there is no point of zero pressure between the two surfaces, since they are pressed together with equal force at all points. Therefore, there is little opportunity for the oil to work between the surfaces, and consequently the bearing is incapable of supporting heavy-unit loads without developing an excessive amount of heat due to friction.

The fact that the ordinary thrust bearing is so inefficient as compared with a journal bearing has led to the introduction of a number of different means for reducing this friction. Special kinds of anti-friction metal have been brought out, also special kinds of engine oil for lubricating the bearing. Others have attempted to solve the problem by using ball or roller bearings, while still others have attempted to so construct the bearing surfaces of the thrust collars that a point of no pressure is obtained, and thus the bearing is lubricated similarly to a journal bearing.

In a paper read before a recent meeting of the Institute of Marine Engineers, Mr. G. B. Woodruff showed a diagram in which the coefficients of friction for both thrust and journal bearings are plotted as curves for varying speeds for different types of bearings. Friction being of two kinds, static and kinetic, it is evident that certain types of bearings may have a low starting friction, which will increase rapidly with the speed, or they may have a high starting friction, which will not increase very materially with an increase of speed. Of course it will depend altogether for what purpose the bearing is to be used whether it is advisable to have the friction a minimum at starting or at high speed. Both thrust and journal bearings have practically the same coefficient of starting friction unless ball or roller bearings are used. In that case there is a very low starting friction, although this advantage is lost when the speed of the shaft is increased.

A theoretically perfect journal bearing shows a sudden drop in the friction when the speed approaches about 10 feet per minute. On the other hand, the coefficient of friction of a flat thrust bearing falls slightly as the speed increases, although there is no sudden drop and the friction remains high. There is, therefore, some change which takes place in a properly lubricated journal bearing which does not take place in an ordinary thrust bearing. This change is the formation of the oil wedge forcing the two surfaces apart, which, as has already been pointed out, does not occur in a thrust bearing.

The chief advantage of a ball bearing is the very low

starting friction which it has compared with an oil-lubricated journal bearing. For heavy loads and high speeds, however, the advantage is not so great.

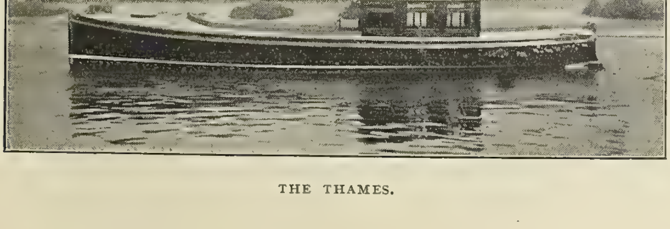
Roller bearings are now made to carry loads varying from a few ounces running at 30,000 revolutions per minute to loads of 250,000 pounds at 500 revolutions per minute and 1,500,000 pounds at 100 revolutions per minute. While such bearings have not been widely used for the thrust and journal bearings on propeller shafts for any except small boats, yet attention is now being turned to development in this direction. There are, however, an almost innumerable number of places on the various machines and tools used in shipyards where they can be used to great advantage. The largest anti-friction thrust bearing which has come to our notice was built by the Standard Roller Bearing Company, of Philadelphia. It is over 4 feet in diameter, weighs nearly 4 tons and carries a load of 1,500,000 pounds, or 750 tons, at 100 revolutions per minute.

For the purpose of ascertaining the relative starting and running friction of roller bearings as compared with ordinary bearings, Prof. Goodman, of the Yorkshire College, Leeds, made an exhaustive series of experiments with them, and gave the following facts as the results of his investigations. The friction per ton of load decreased as the load increased. Under a pressure of 100 pounds at 40 revolutions the bearing friction was at the rate of 8.512 pounds per ton of load, but under a pressure of 10,000 pounds at the same speed the friction had decreased to 3.584 pounds per ton of load. Speed had very little effect upon the coefficient of friction. In the case of a load of 1,000 pounds the coefficient was constant between the speeds of 40 and 480 revolutions per minute, but in the case of a load of 10,000 pounds it varied from .0016 at 40 revolutions to .0013 at 160 revolutions, and remained constant at this figure to 480 revolutions, the highest speed obtainable in the trials. The slight friction to be overcome in starting was practically the same as the running friction, while the end thrust was practically eliminated.

Ball bearings were not accepted at first without prejudice, because the balls were frequently found to break. Exhaustive investigations have, however, shown the proper proportions to be used in designing such bearings, so that now the same reliability can be claimed for these as for any other type of bearing. Manufacturers usually claim a saving of from 30 to 40 percent in power and oil by their use. The balls are now manufactured with marvelous accuracy, some being guaranteed correct to 1,000 of a millimeter and absolutely round.

The Thames Conservancy Motor Launch "Thames."

For some time past the Thames Conservators have found the small motor launch of considerable assistance to them in their duties, and the experience gained with the boat *Thames*, delivered by Messrs. Thornycroft in the late summer, has demonstrated the advantages to be derived from the use of larger craft of this description. The *Thames* is 45 feet long by 8 feet beam and 2 feet 7 inches draft. She is carvel-built of mahogany, with frames of American elm, decks of Kauri pine, stem and sternpost of English oak and keel of American elm. All of the scantlings are of sufficient strength for sea or river use, as the launch is intended for patrolling the Thames from Oxford down to the mouth of the river. A cabin is fitted aft which contains a toilet, a pantry with shelves and sink, and a saloon with table, lockers, etc. The boat is provided with a folding canvas hood forward and a canvas awning over the after well, the motor being protected by a mahogany casing with hinged panels.



THE THAMES.

The motor has six cylinders, each with a diameter of 4½ inches and a stroke of 5 inches, developing 45 brake-horsepower at about 1,000 revolutions per minute. The cylinders are of close-grained cast iron and water-jacketed, the circulating water being provided by a pump of the rotary gear type. Lubrication is forced by means of a pump. A reversing gear is fitted of the Thornycroft type in conjunction with a solid propeller. On her trials the launch attained a speed of 12 miles per hour.

The Motor Launch "Butterfly."

The *Butterfly*, which is a launch of a very staunch and serviceable type, is intended for cruising in the Bay of Smyrna. She is carvel-built of teak, with American elm timbers, 35 feet long by 7 feet beam, and with a draft of 2 feet 3 inches. There is a roomy cabin forward with hinged porthole lights. The decorations are in white and gold, with upholstery of scarlet. The seats are provided with swing edges, to give increased width for use as sleeping berths. A 7-foot collapsible canvas boat is carried as a dinghy.

THE BUTTERFLY.

The boat is fitted with lifting slings, spray hood, awning, with deep sides as protection against the sun, and a hinged mast for emergency purposes, which carries a balance lug sail.

The machinery consists of a Thornycroft M4 engine and reversing gear. This engine has four cylinders, each 4½ inches by 5 inches, and easily develops 30 brake-horsepower on the Russian or Roumanian kerosene, which is the only fuel obtainable in Smyrna. The "M4" is one of Messrs. Thornycroft's latest productions, and is specially designed for arduous marine work, having specially large bearings, crankshaft and camshaft, with a very substantially designed crankcase. The consumption of fuel is about .9 pint per brake-horsepower per hour. The cylinders are of strong design, with ample jackets, having large doors for cleaning. The ignition is by a high-tension magneto, which gives good results with kerosene fuel. The water circulation is maintained by a gear pump. Forced lubrication is fitted with a simple relief valve, by means of which the oil pressure can be regulated as desired and as required by the condition of the bearings.

The guaranteed speed of the boat on Russian kerosene was 11 miles an hour, and about 11¼ miles was easily attained on the trial spins.

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For the Advancement of Naval Architecture.

Two bequests have recently been made which will unbdoutedly do much to advance the science of naval architecture. In response to the appeal of Professor Watkinson, who occupies the chair of engineering at Liverpool University, for the foundation of a chair of naval architecture in that city, Mr. Alexander Elder, the well-known shipbuilder, offers to provide a capital fund of $60,831 (£12,500) for this purpose. Also, by the will of the late Dr. Francis Elgar a sum of $7,786 (£1,600) is left to the Institution of Naval Architects for the endowment of a scholarship to be awarded as the Council may decide. After making other bequests, one-half of the residue of the Elgar estate, which will apparently amount to between $156,000 (£32,000) and $166,000 (£34,000), is eventually to be divided equally between the Institution of Naval Architects for the encouragement of the science and art of naval architecture and the University of Glasgow, to be held in trust for the furtherance of the objects of the John Elgar chair of naval architecture in that university.

It is to be hoped that before long means will be found for providing every technical school or college in which there is a department of naval architecture with a well-equipped experimental tank for towing models. This need is very urgent both in the United States and Great Britain. In the United States there is at present, with the exception of the Government tank at Washington, only one other model towing basin in operation in the country; while in England, with the exception of the Admiralty tank, there are only two others, and as these are owned by private shipbuilding firms there is little chance to use them for research work. A well-equipped experimental towing tank is, of course, a costly piece of apparatus, and one which is expensive to operate and maintain. On the other hand, there is no more valuable means of investigating the various problems which must be solved by a naval architect than by such a tank, and under the direction of such men as are at the head of our schools of naval architecture such an establishment would have an incalculable value. Shipbuilders and others interested in the advancement of the science of naval architecture would do well to give the needs of technical schools and colleges more thought.

An Innovation.

The American Society of Naval Architects and Marine Engineers has decided to hold in future a semi-annual meeting sometime during the spring or summer months at some Western city. This year the meeting will be held at Detroit, Mich., probably the last week in June. Only three or four papers will be read each day, the remainder of the time being devoted to inspecting shipyards and various other industrial works. Any increase in the activities of this society, which in the past has done so much to advance the science of naval architecture, is, of course, to be gladly welcomed; yet the attendance and amount of interest shown at the annual meetings of the society in New York seem to us hardly sufficient to warrant this new departure. The fact that the meetings are to be held in some Western city may serve to stimulate the interest of lake shipbuilders in the activities of the society, and, if so, the attempt will have been worth while.

Large Ships and Ocean Travel.

Due very largely to the industrial panic, passenger traffic between the United States and Europe last year showed a decrease of 940,000 passengers and a decrease of about $29,199,000 (£6,000,000) in revenue. This decrease in travel, coming at a time when a few of the largest and fastest ships crossing the ocean were at the height of their popularity, caused at least one conservative line in the North Atlantic trade to suspend dividends for the year. The tendency to travel in the largest, fastest and most luxurious vessels has been steadily growing of late, so that vessels of this type are the first to earn dividends in a dull year. Bookings for travel during the coming season have been fairly good, especially for mid-summer travel, and with the return of normal business conditions undoubtedly the smaller and slower boats will again be largely favored, because under these condi-

tions a greater number of people of moderate wealth will be traveling.

The world-wide depression in shipbuilding following two years of unusual activity and overproduction will probably call a halt on the building of extremely large vessels for a short time. Except for the new White Star liners *Olympic* and *Titanic*, no unusually large vessels are now projected. Since the launch of the White Star liner *Celtic* in 1901, marking the advent of ships of over 20,000 tons gross, fourteen ships exceeding this tonnage have been laid down. During the four years, 1892 to 1895, an average of eight vessels of 6,000 tons and upwards were launched per annum in the United Kingdom. In the following four years, 1896 to 1899, the average rose to twenty-five, and to thirty-nine for the four years 1900 to 1903. It dropped to twenty-seven for the four years 1904 to 1907, and during 1908 twenty-eight such vessels were launched. Of vessels of 10,000 tons and upwards only three were launched in the four years 1892 to 1895; seventeen were launched during the four years 1896 to 1899, while thirty-two were launched during the four years 1900 to 1903, and twenty during the four years 1904 to 1907. During 1908 ten vessels of 10,000 tons and above were launched. Of these, only one, the *Rotterdam,* was over 20,000 tons. In the United States the largest sea-going merchant steamer launched during 1908 was the *Oklahoma,* of 5,853 tons, and she was the only one of over 5,000 tons launched on the coast during the year.

The Outlook in Shipbuilding.

According to Lloyd's Register, the total output of the shipyards of the world during 1908 (exclusive of warships) was 1,833,286 tons (1,706,179 steam, 127,107 sail). According to the latest returns received by Lloyd's, the tonnage of all nationalities totally lost, broken up, etc., during the twelve months amounts to about 794,000 tons (557,000 steam, 237,000 sail). The net increase of the world's mercantile tonnage at the end of 1908 is thus about 1,039,000 tons. Sailing tonnage has been reduced by 110,000 tons, while steam tonnage has increased by 1,149,000 tons.

Of the tonnage launched during 1908, the United Kingdom has acquired over 30.25 percent. Of the total merchant tonnage output of the world during 1908, 50.75 percent was launched in the United Kingdom; but, if only seagoing steel steamers of 3,000 tons gross and upwards be taken into account (thus excluding vessels trading on the North American Lakes), out of the total of 179 such steamers of 1,050,741 tons launched in the world, over 63.33 percent of the tonnage has been launched in the United Kingdom. The output of mercantile tonnage in the United Kingdom during 1908 shows a decrease of 678,221 tons on that of last year, and is the lowest total recorded for fifteen years. The Glasgow district occupied the first place among the principal shipbuilding centres of the country, showing an output of 233,830 tons. Then follow in order Newcastle (174,259 tons), Belfast (153,517 tons), Greenock (103,470 tons), Sunderland (86,547 tons), Middlesbro' (57,210 tons), and Hartlepool (37,843 tons). In warship tonnage Newcastle leads with 21,830 tons, followed by Devonport and Portsmouth with 19,250 tons each.

In the United States the output was 287,603 tons, showing a loss of 42 percent as compared with 502,508 tons for 1907. The returns from Germany show a decrease of over 67,000 tons as compared with 1907. During the years 1900-1904 the average yearly output was about 204,000 tons. In 1905, 255,000 tons were launched, and in 1906, 318,000 tons. Since then there has been a considerable decrease, the present figures (207,800) being 110,000 tons less than two years ago. The tonnage launched in France, which had shown the striking decrease of 157,000 tons from 1902 to 1906, has since steadily increased. The figures for 1907 were 26,000 tons better than those for 1906, and the present total (83,400 tons) is 22,000 tons larger than that of 1907. The returns from Denmark, Holland, Italy, Japan and Norway show decreases of 33, 15, 40, 10 and 8 percent, respectively, while in Austria-Hungary there was an increase of about 170 percent over 1907. The totals for all other countries indicate a decrease of about 13 percent.

Having passed through a year of such universal depression, it is natural for shipbuilders to look forward to better conditions during the present year. The labor troubles, which assumed such formidable proportions in English yards during 1908, have been satisfactorily settled; but the amount of orders for new tonnage so far booked is discouraging, neither does there seem to be much prospect of an immediate increase of business. The past few years have witnessed the production of a large number of big ships, and it is unlikely that activity in this direction will be resumed for some time. A healthy improvement in the carrying trade of the world, however, must necessarily stimulate the building of medium-sized vessels of moderate speed and of large cargo capacity which are capable of earning dividends without the aid of large government subsidies.

In America all hopes of a boom in shipbuilding during the present year were destroyed by the defeat in Congress of the ocean mail subsidy bill providing an increased mail subsidy to ships of 16 and 14 knots speed running to South America, the Philippines, China, Japan and Australasia. This is the third time in two years that substantially the same measure has been defeated, and always on the same grounds. Opponents of the measure are, however, gradually losing ground, and, with the advent of the new administration, it is confidently believed by many that success is at hand. It seems hardly possible that a measure which has received the endorsement of both great political parties, and which has received the hearty support of two successive administrations, can much longer be suppressed.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

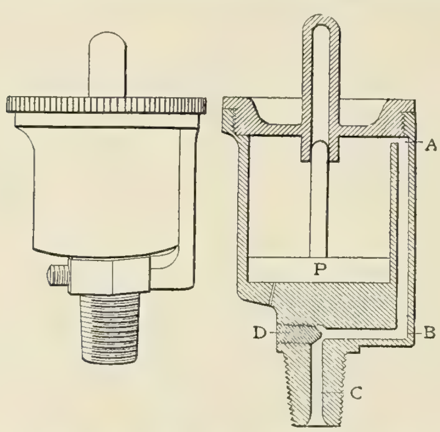
	Tons.	Knots.		Feb. 1.	Mar. 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons.........	78.9	82.3
Michigan ...	16,000	18½	New York Shipbuilding Co..	89.7	93.0
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	64.1	68.5
North Dakota	20,000	21	Fore River Shipbuilding Co...	70.6	74.5
Florida	20,000	20¾	Navy Yard, New York......	3.3	4.8
Utah	20,000	20¾	New York Shipbuilding Co..	3.1	5.6
TORPEDO-BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons.........	65.2	67.8
Lamson	700	28	Wm. Cramp & Sons.........	63.8	66.3
Preston	700	28	New York Shipbuilding Co...	59.3	60.2
Flusser	700	28	Bath Iron Works............	55.3	60.6
Reid	700	28	Bath Iron Works............	54.6	60.0
Paulding ...	742	29½	Bath Iron Works............	3.7	5.0
Drayton	742	29½	Bath Iron Works............	3.7	5.0
Roe	742	29½	Newp't News Shipbuilding Co.	10.2	17.6
Terry	742	29½	Newp't News Shipbuilding Co.	9.5	17.1
Perkins	742	29½	Fore River Shipbuilding Co...	6.7	11.7
Sterrett	742	29½	Fore River Shipbuilding Co...	6.7	11.7
McCall	742	29½	New York Shipbuilding Co...	5.8	8.2
Burrows	742	29½	New York Shipbuilding Co...	5.8	8.1
Warrington..	742	29½	Wm. Cramp & Sons.........	6.2	8.4
Mayrant	742	29½	Wm. Cramp & Sons.........	6.5	8.1
SUBMARINE TORPEDO BOATS.					
Stingray	...	..	Fore River Shipbuilding Co..	69.9	77.5
Tarpon	...	..	Fore River Shipbuilding Co..	71.0	76.2
Bonita	...	..	Fore River Shipbuilding Co..	68.4	71.5
Snapper	...	..	Fore River Shipbuilding Co..	65.6	71.0
Narwhal ...	...	..	Fore River Shipbuilding Co..	70.0	74.4
Grayling ...	...	..	Fore River Shipbuilding Co..	64.7	70.7
Salmon	...	..	Fore River Shipbuilding Co..	61.3	64.2
Seal	...	..	Newp't News Shipbuilding Co.	0.0	4.6

ENGINEERING SPECIALTIES.

A Loose Pulley Oil Cup.

The Lawson Manufacturing Company, Buffalo, N. Y., has placed on the market a new oil cup for keeping loose pulleys constantly oiled while in operation. The cup consists of three distinct parts—a body, piston or plunger, and an oil-tight cover, all parts being made of a special Swiss brass, highly polished.

The cup is filled with ordinary lubricating oil by unscrewing the cover after making sure that the plunger is pushed clear

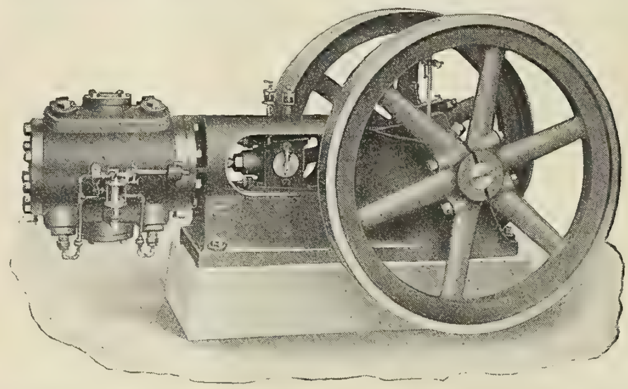


down. After the cup has been filled, the cover is then replaced and the device is ready for use. A stem with standard threads screws into the hub of the pulley. When the pulley begins to revolve, centrifugal force causes the piston in the cup to force itself upward, thus forcing the oil to flow down through the by-pass to the shaft on which the pulley is revolving. The flow of the oil is controlled by a screw which must be regulated according to the speed of the pulley. When the pulley stops, oiling ceases at once, but begins again just as soon as the pulley is started. The cup is made in two sizes, one for pulleys having diameters from 6 to 12 inches, and the other for pulleys having a diameter above 12 inches.

Dallett Air Compressors.

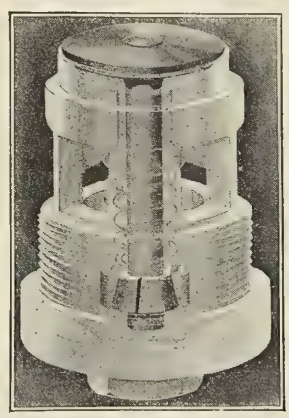
A line of air compressors built by Thos. H. Dallett & Company, Philadelphia, Pa., shows many excellent and unique ideas in design. These compressors are designed so that all parts requiring adjustment or renewal are readily accessible, and by using a liberal amount of metal, rigidity in operation is insured. The capacity of any compressor may be increased by replacing its air cylinder by that of its next larger size.

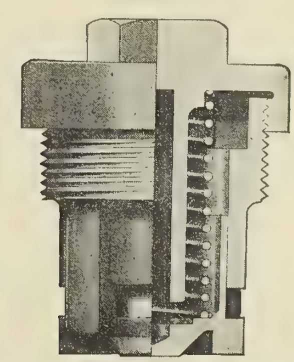
The frame is of the open-fork center crank type. The duplex belt, duplex steam and single steam machines are supported on a deep, rigid sub-base, thus making the entire machine self-contained. The main bearings are lined with a high grade of Babbitt metal, which is poured into dove-tailed recesses and well pinned in to prevent shrinkage. Lubrication is



effected by sight-feed devices, gravity or a force-feed system, drainage being provided for all drips from the guides, stuffing-boxes and the crank pit.

The steam cylinder and valve gear of the steam-driven machines are well suited to the operation of compressors, giving high efficiency with little attention. The clearance has been reduced to a minimum. A plain *D* balanced slide valve is used on the small and medium-sized machines, while the Meyer balanced, adjustable, cut-off valve is used on the large machines. The rocker arms on all valve gears are adjustable to compensate for wear. On the steam-driven machines, the





governor is equipped with a safety-stop device, which stops the machine on a breaking of the governor belt. The governor pulley is placed on the end of the shaft outside of the fly-wheel on the single machine, thus bringing the fly-wheel as close to the bearings as possible, and also preventing oil or grease, thrown by the eccentric, from getting on the governor belt. A reducing valve is used on the duplex compressors with compound steam cylinders, which reduces the live steam pressure for use in the low-pressure cylinder. If the high-pressure side stops on the dead center, live steam is fed to the low-pressure cylinder through the reducing valve for starting. The live steam is taken into the low-pressure side only when starting, otherwise the operation is identical with any compound machine.

The air cylinders are of special hard, close-grained iron, and each is thoroughly tested under hydraulic pressure of 200 pounds before assembling. The clearance space is reduced to a minimum, and all heads and cylinder walls are thoroughly water-jacketed. Oil is fed directly into the intake passage, and the suction carries it into the cylinder in the form of a fine spray.

The cross head is a new type box pattern, made of semi-steel. The shoes are adjustable and have large bearing surfaces. The upper shoe is lubricated by a sight-feed lubricator, and the lower one runs in oil. One of the features of this design is the side openings, which allow easy access to the binder nuts. The intake valve, of the automatic poppet type, is contained in a malleable iron cage. The cage is one piece, and combines both seat for the valve and guide for the valve stem. The cage is threaded, and screws into the wall of the air-intake chamber only, and is simply seated in a recess on the main cylinder wall. The valve proper is a special alloy hardened steel, with seat and stem ground to gage. The valve spring is of phosphor bronze. To eliminate the shearing off or loosening of valve spring holders, the "Dallett" spring holder comprises a split taper ring set into a recess on the valve stem, and held together by means of a solid taper ring slipping down over it. The hammering of the valve on its seat tends to tighten the spring holder on the stem instead of driving it off. The discharge valve is of the automatic poppet type, contained in a valve cage of malleable iron. The method of seating in the cylinder and locking to its seat is identical with that of the intake valve.

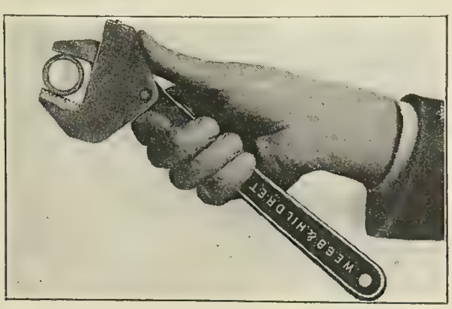
The inter-cooler plays a very important part in the economical operation of a two-stage machine. The "Dallett" inter-cooler employs the return-flow type of water circulation, using baffle plates to deflect the flow of air and in its effectual contact with the cooling tubes. The nest of cooling tubes may be removed intact from the inter-cooler box without disturbing any of the piping, as unions are supplied.

Automatic regulation of the supply of air is secured by an unloading device. When a certain determined pressure is reached in the air receiver, one or more inlet valves are held open, and the load is taken off the compressor, allowing it to run light until the pressure drops in the receiver, upon which the valves are released and air compression is resumed. On the steam machines a combined speed and pressure governor is used.

The Dallett compressors are built in sizes ranging from an 8-inch stroke up to a 16-inch stroke, giving a range of capacity from 79 cubic feet of free air per minute to 1,200 cubic feet.

A New Automatic Wrench.

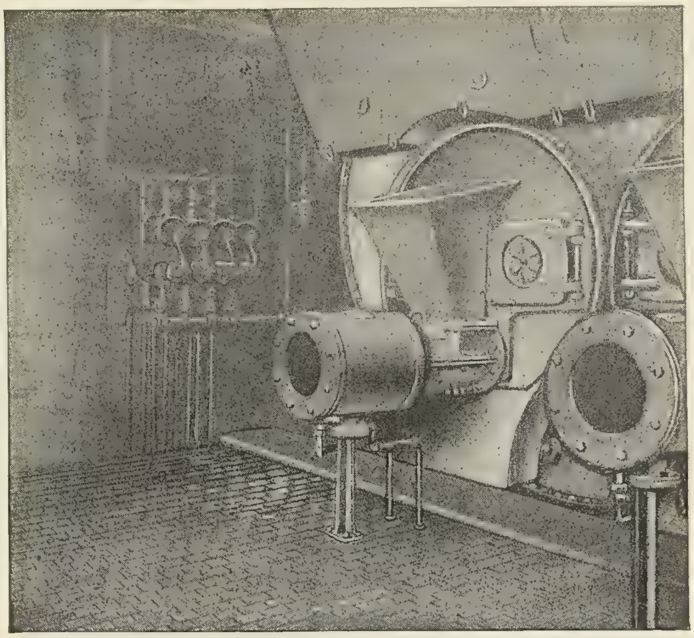
The Webb & Hildreth Manufacturing Company, 9 Forest street, Gloversville, N. Y., recently placed on the market a new type of automatic wrench, which can be quickly adjusted



for use on pipe, nuts, lag screws, etc. As shown by the illustration, the wrench is simply constructed and convenient to handle. It is claimed that the wrench is perfectly reliable.

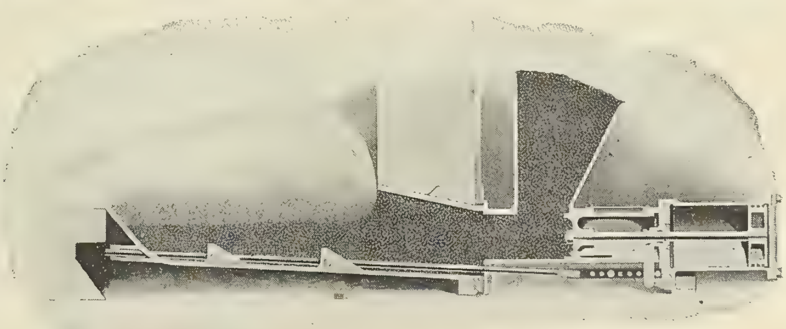
The Jones Underfeed Mechanical Stoker.

Economy in fuel, steady steam and increased efficiency, saving in labor and the abatement of smoke are the principal advantages claimed for the Jones underfeed mechanical stoker, manufactured by the Underfeed Stoker Company of America, Detroit. For several years stokers of this type have



been successfully used on land, but it is only recently that the marine stoker has been developed. All the advantages secured in sationary installation are obtained on board ship, with the added advantage that some of the hardest labor ordinarily performed on shipboard is eliminated. As shown in the illustration, coal is fed into the hopper, and from there forced by a ram underneath the fire. The ram is operated by a piston working in a steam cylinder. Due to the limitations of space on board ship, the regular type of Jones stoker has been modified by shortening the cylinder and ram case, effecting a reduction of nearly 18 inches in the length of the external parts. The internal construction remains the same as in the standard type of stoker.

Jones stokers have been installed on a number of large lake steamships with favorable results. On the *James E. Davidson,* of 6,206 gross tons, it is claimed that these stokers, in connection with Niclausse boilers, effected a saving of 25 percent in coal consumption, while on the *Eugene Zimmerman,* of 5,630 gross tons, fitted with Scotch boilers, it is claimed that the fuel bill for a single season was $1,000 less than that of a sister ship hand fired. Furthermore, the vessel

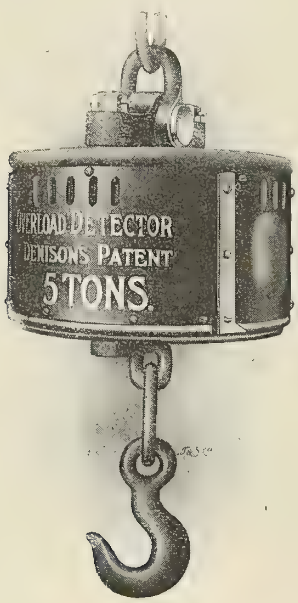


was able to carry six thousand tons more cargo on each round trip, and traveled 1,000 miles more than her sister ship during the season.

A Patent Overload Detector for Cranes.

The illustration shows a patent overload detector for cranes, manufactured by Samuel Denison & Sons, Hunslet Foundry, Leeds. This apparatus is intended to form a permanent part of the crane chain, and not to be detachable at will.

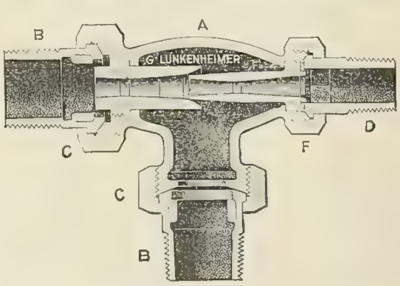
The detector gives instantaneous warning if a load greater than that for which the crane was designed is lifted, even if



it is only 1 inch off the floor. With this attachment, therefore, there can be no excuse for a workman to damage an expensive crane equipment by overloading or working it beyond its capacity. Not only is damage to the crane prevented, but serious accidents in the shop are likewise eliminated.

An Improved Ejector.

In the improved ejector manufactured by the Lunkenheimer Company, Cincinnati, Ohio, the tubes are made of a very hard grade of bronze, especially adapted for the severe service to which ejectors are generally subjected. They are screwed into the body of the ejector instead of being secured by means of unions. The latter is the method generally employed, but it has been found that tubes become lost or damaged when re-



moving the union; therefore the improved method of construction has been adopted. It is claimed that this ejector is especially economical because of the improved shape of the tapers inside the tubes, which require a less amount of steam for lifting a given quantity of water than other types of ejectors. To operate the device it is only necessary to turn the steam on full head, and after getting the flow of water established the steam can be throttled to a very low degree. As shown by the following tables, the ejector is capable of lifting water at a high temperature to a great height, and also forcing it against a great head. The ejector is made in sizes capable of lifting from 250 to 1,100 gallons of water per hour at 75 degrees F. to a height of 20 feet, with a steam pressure of 50 pounds.

The following tables give the amount of lift, together with the height that the ejector will force when placed about 5 feet above the water level:

LIFT OF EJECTOR GIVEN IN FEET. FEED WATER 75 DEGREES F.

Pres., lbs..	5	10	15	20	25	30	40	50	60	70	80	90	100
Lift, feet..	3	7	11	15½	21	21	20	19	18	17½	16½	15½	14½

Height (in feet) ejector will force when placed 5 feet above water level:

FEED WATER 75 DEGREES F.

Pressure, pounds.......	20	30	40	50	60	70	80	90	100
Height, feet............	18	28	36	46	57	66	74	84	92

TECHNICAL PUBLICATIONS.

Notes and Drawings of a Four-Cylinder Petrol Engine. By Henry J. Spooner, C. E. Size, 15 by 10½ inches. Pages, 16. Plates, 11. London, 1908: Longmans, Green & Company. Price, 2s.

The author, from a long and varied experience in teaching in technical schools and colleges, has found that there is a great scarcity of drawings of complete machines, and, realizing that if students are to become useful draftsmen, they must not only become proficient in drawing details of machines, but they must also be be able to correctly project one view from another, to make additional sectional views and to exercise their judgment in deciding upon suitable sizes for the many little refinements and minor details which would be necessary for them to decide in designing a complete machine. For this reason complete drawings of a petrol engine are given, this type of engine being selected chiefly from the interest which engineering students take in all that pertains to motor engineering. For the benefit of those who are not acquainted with the details of this type of engine, the various parts and the operation of the engine are carefully described.

Textbook of Theoretical Naval Architecture. By Edward L. Attwood. Size, 4¾ by 7¼ inches. Pages, 458. Figures, 145. Plates, 5. London, 1909: Longmans, Green & Company. Price, 7/6 ($2.50).

The fact that five editions of this book have been called for since it first appeared in 1899 gives a good idea of the value of the work. It was originally written in order to provide students and draftsmen engaged in shipbuiders' and naval architects drawing offices with a convenient textbook which would explain fully the ordinary calculations pertaining to ship design. The book is not confined, however, to a description of elementary calculations, for the latter part of the book is intended to serve as a textbook for the theoretical portion of the examinations of the Art and Science Department in Naval Architecture at the Royal Naval College, Greenwich.

A valuable feature of the book is the large number of examples given in the text and at the ends of the chapters, by means of which the student can test his grasp of the principles and methods described in the text. Most of these examples have been taken from actual drawing-office calculations, so that the student may get a good idea of the sort of work which will be required of him in such an office.

There are eight chapters, dealing, respectively, with areas, volumes, weights, displacement, etc., moments, center of gravity, center of buoyancy, displacement measurements, etc., conditions of equillibrium, transverse metacenter, moment of inertia, metacentric height, etc., longitudinal metacenter and change of trim, statical and dynamical stability with calculations of weights, strength of butt connections, stresses in ship structures, and resistances and propulsion.

The Story of the Submarine. By Col. C. Field. Size, 5¼ by 8 inches. Pages, 304. Over 100 illustrations. London, 1908: Sampson Low, Marston & Company, Ltd. Price, 6s. ($2.00).

A large part of this book is of an historical nature, describing the early development of submarine boats and other apparatus. The book does not claim to be a work of reference, but is rather intended to satisfy the curiosity of the casual reader. Technicalities and diagrams which would be of value in a scientific work are, therefore, omitted, and the various phases of submarine warfare are described in a very general way. Perhaps no branch of marine engineering has appealed so much to the imagination of inventors as submarine navigation. At any rate, the great number of impractical and amusing schemes which have been evolved will readily appeal to the imaginative reader, affording him entertainment if not instruction.

Suction Gas Plants. By C. Alfred Smith, B. Sc. Size, 5¼ by 7½ inches. Pages, 198. Illustrations, 55. London, 1909: Charles Griffin & Company, Ltd. Price, 5s. net.

Recently a special course of three lectures on suction gas plants was given at the East London College. This course aroused such widespread interest that numerous requests were made for the publication of the subject matter. This work, therefore, includes the text and illustrations of these three lectures, the first lecture taking up the details of construction of apparatus, the production of steam, fuel and testing. The second lecture describes the operation of typical plants and the application and uses of suction plants. The third lecture describes plants for special purposes, pointing out the advantages and disadvantages of a suction gas plant, and giving some data on the cost of gas production. The book undoubtedly comprises the most complete treatment of suction gas plants which has yet come from the press.

Les Flottes de Combat en 1909. By Commandant Balincourt. Size, 6 by 4¾ inches. Pages, 751. Figures, 357. Paris and Nancy, 1908: Berger-Levrault & Company. Price, 5 francs.

The previous editions of this book have been carefully reviewed in our columns, so that an extended description of the work is unnecessary. This is the eighth edition, and comprises the usual features which are incorporated each year, namely: the illustration and description of the principal features of all important warships in the world, classified according to the nations to which they belong. The illustrations consist of line drawings, showing the outboard profile and the deck plan of the vessels, indicating the positions of guns and armor as well as the size of guns and thickness of armor. A description of each vessel includes the principal dimensions, horsepower, speed and steaming radius, the number and size of the guns carried, and the extent and thickness of armor.

A new feature which has been introduced into the present edition is a recapitulation of the naval strength of each country, in which the total displacement and number of guns of different sizes are given for each class of ships in the navy. This affords an opportunity for the reader to obtain at a glance an accurate idea of the comparative sizes and offensive powers of the different navies of the world.

OBITUARY.

Ervin Saunders, vice-president of D. Saunders Sons, Inc., died at Yonkers, N. Y., Wednesday, February 17.

Henry Bausch, second vice-president of the Bausch & Lomb Optical Company, died at Augusta, Ga., March 2. Mr. Bausch has been identified with the Bausch & Lomb Optical Company during his entire lifetime, his father having been one of the organizers of the business.

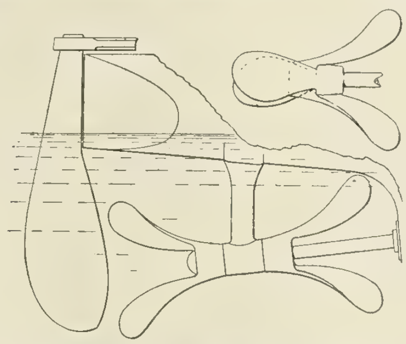
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent atorney, Loan & Trust Building, Washington, D. C.

865,364. PROPELLER. FREDERICK A. DOUSE, OF SEATTLE, WASH.

Claim 3.—In combination with a shaft, two propellers, each consisting of a hub having oppositely flattened surfaces and with two helical blades extending from the remaining opposite sides of the hub in diverging



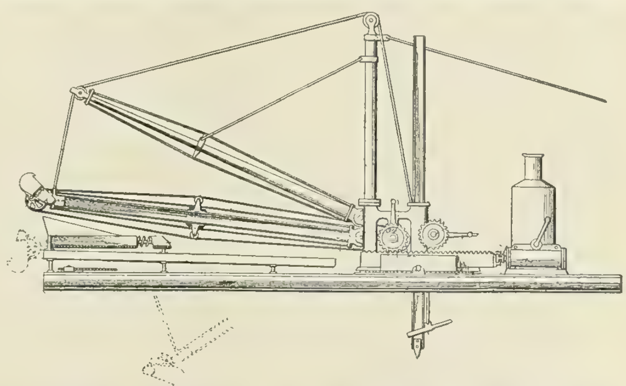
curved lines and increasing in pitch and likewise in width toward their free end and arranged upon the shaft and with the blades extending in opposite directions. Three claims.

908,690. DIVING GEAR OR THE LIKE. ALOIS NEUBERT, OF NEW YORK, N. Y., ASSIGNOR TO A. SCHRADER'S SON, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—In a diving apparatus or the like, the combination of an air tube through which the air is led to the operator, and a trap connected with such tube and adapted to receive moisture therefrom, such trap comprising an enlarged chamber into which such tube leads, whereby the moisture cannot follow the tube to the operator. Twenty-three claims.

909,063. GOLD DREDGE. HORACE J. CLARK, OF CHICAGO, ILL., ASSIGNOR TO CLARK DREDGE MANUFACTURING COMPANY, OF CHICAGO, ILL., A CORPORATION OF MAINE.

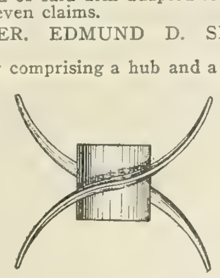
Claim 1.—In a dredge, the combination with a hull having a longitudinally extending channel opening, of a scoop arm pivotally mounted



in said opening intermediate of the ends of the hull, and an oscillating scoop upon the free end of said arm adapted to discharge upon one end of said hull. Twenty-seven claims.

909,246. PROPELLER. EDMUND D. SPEAR, OF BOSTON, MASS.

Claim 2.—A propeller comprising a hub and a plurality of blades, each

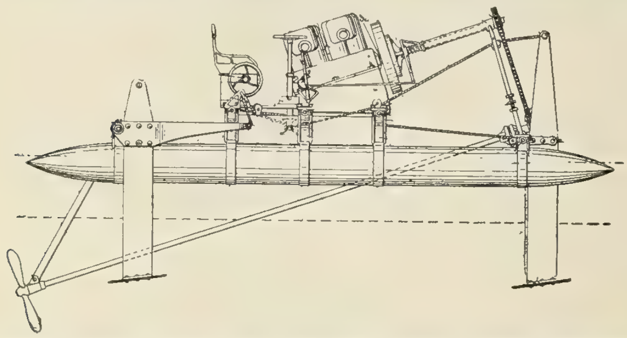


of which has a driving surface in the form of a convexed conchoidal curve extending transversely thereof. Two claims.

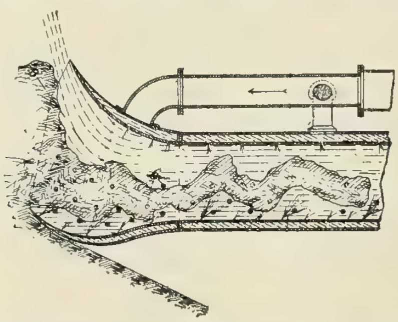
910,899. REVERSING PROPELLER. OLIVER A. BOWERS, OF MILFORD, MASS., ASSIGNOR TO C. F. ROPER & CO., OF HOPEDALE, MASS., A FIRM.

Claim 1.—A shaft adapted to be rotated in one direction at a substantially uniform speed, a propeller mounted thereon comprising two oppositely located and angularly-movable blades, and a single means to reverse the angularity of said blades and connected with both, said means operating to turn one blade to full reversed position while holding the other blade in its original position and thereafter turning the last-mentioned blade to its full reversed position while the first-named blade is maintained in full reversed position. Nine claims.

909,468. HYDROPLANE BOAT. LOWE E. SIMPSON, OF COLLEGE HILL, OHIO.
Claim 2.—In a hydroplane boat, the combination of a normal supporting body, hydroplane frames pivoted thereto, said hydroplane frames comprising hydroplanes, a pivoted manipulating drum, and flexible connections between said drum and hydroplane frames whereby said hydroplane frames may be simultaneously swung about their pivots by revolving said drum, and whereby said hydroplane frames may be manipulated by swinging said drum upon its pivot. Seven claims.

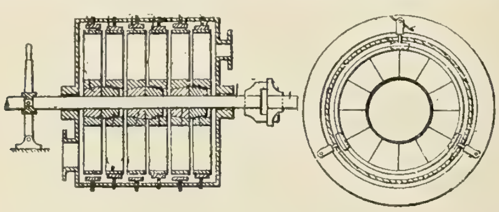


909,543. DREDGING APPARATUS. JULIO CARLÉSIMO, OF BUENOS AYRES, ARGENTINA.
Claim 1.—In a dredging apparatus, a suction device comprising an outer conduit, a conduit mounted within the latter forming a chamber, means to supply a lubricant to said chamber, and means to inject the lubricant from said chamber onto the material passing through the inner conduit. Five claims.

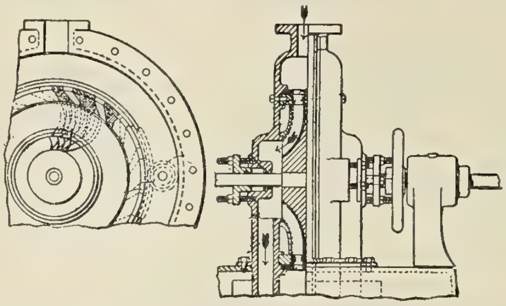


British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

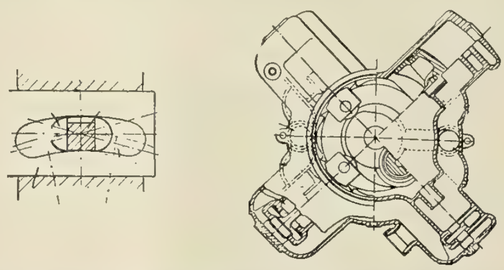
19,958. TURBINES. A. FAYWISCHEWITSCH, MITTWEIDA, GERMANY.
A turbine comprising alternate sets of fixed and movable blades or disks is reversed by coupling the fixed blades to the shaft, and at the same time uncoupling the previously movable blades and clamping them to the casing. The shaft is provided with conical wheels having screw threads on their surfaces adapted to engage with the screw threads provided on the interior surfaces of the hubs of the disks, the adjacent cones being oppositely inclined. The alternate disks are in engagement with the shaft, the others being free from the screw threads on the wheels and held stationary by clutches passing through the casing. The clutches are actuated by rings outside the casing, the rings having cam-slots which actuate the clutches when the wheel is turned. The clutch may engage with a groove in the peripheral edge of the disks and is forked at its outer end, the forked members being joined by a bolt which passes through the cam-slot in the disk. Similar rings with oppositely-inclined cam-slots are provided for the clutches which hold the alternate disks when the engine is reversed, the inertia of the shaft causing it to continue to rotate after the disks are stopped by the clutches. The shaft thus unscrews itself from the hubs and is then given the necessary longitudinal movement to cause it to engage with the other set of hubs. The remaining disks are simultaneously released from the clutches. A special coupling connecting the main shaft with the driven shaft allows the necessary longitudinal movement to be given by a lever without breaking the connection. The clutch-actuating rings may be connected together, so that one movement causes the engagement of one of the sets of clutches and the disengagement of the other set.



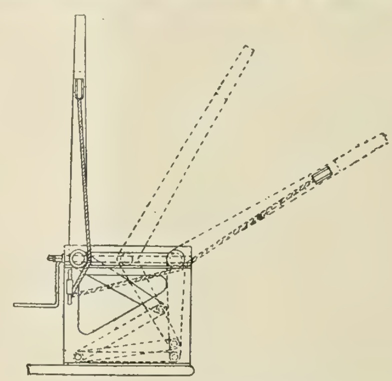
20,130. TURBINES. W. B. MILLER, CHRISTCHURCH, NEW ZEALAND.
A duplex inward-flow turbine is constructed as shown. Steam from an annular chest is delivered by nozzles upon gouge-shaped rotor blades on each side of a disk and exhausts in an axial direction into a chamber. The nozzle ports are formed in an annular partition and are controlled by a slide ring-valve actuated by a rack and pinion, the spindle of the pinion being provided with a hand wheel outside the casing. Rings secure the outer edges of the blades, and alternate blades are shortened to provide a free exit for the steam. The joints and bearing faces are made steam tight. Several forward engines and a reversing engine may be arranged on the same shaft.



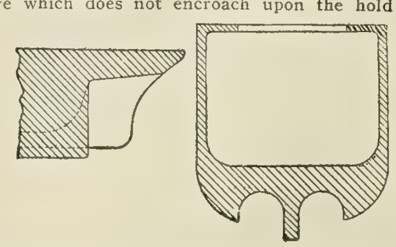
20,274. SCREW PROPELLERS. H. PAWLIK, BUDAPEST.
Relates to mechanism for varying the pitch by turning the blades in their settings. Each blade carries a stud in a guide piece moving in the curved guide slot of a slide capable of being longitudinally displaced along the propeller shaft. The blades are journaled in that part of the boss outside the slide by means of a thickened end of the blade, which is retained by caps and has its bearing in shells. Owing to the curved shape of the slots the movement of the slides necessitates a slight transverse motion of the studs relatively to the slide.



20,801. BOAT-RAISING GEAR. S. HANCOCK, WEST BRIDGFORD.
The boat davits have the lower ends bent at an angle to the upper parts and are supported on rollers moved in a slot in a frame by a screwed spindle. Radius bars mounted on a pin are attached to the lower end of the davits, and when the davits are outboard the radius bars are horizontal and the lower ends of the davits vertical. The fall of the boat tackle is led through a guide and round a sheave on the davit trunnion, causing the boat to be slightly raised as the davit travels outboard.



21,429. SHIPS' HULLS. A. JAKOBSEN AND G. HUGHES, GRIMSBY.
The hulls of vessels are provided along each side of the keel with a shallow groove which does not encroach upon the hold space. These grooves run the full length of the ship and lead into a recess or open chamber extending upwardly into the stern beyond the end of the keel. The grooves are stated to add to the ship's stability and prevent excessive rolling.



International Marine Engineering

MAY, 1909.

THE BATES ELECTRICALLY DRIVEN HYDRAULIC DREDGER.

A Bates hydraulic dredger was recently constructed by the Société J. Cockerill at their Belgian works at Liege for the Russian government. The arrangement of the engines, pumps and electric generators, as well as the cutters and cutter mechanism, is shown in Fig. 2. The dredge is constructed in two parts, forming a double dredge, or the equipment may be considered as two separate dredges working side by side. The width was limited to the canal system Marie, through which it was necessary for her to pass on her way to the Volga from the Baltic. The double dredge, operating as a whole, makes a cut 62 feet wide at the bottom. Each half can also be operated separately when desired. Each half is 9 feet deep, 216 feet long and a trifle over 31 feet wide. The working draft is less than 5 feet.

FIG. 1.—BATES DREDGERS, SHOWING LOCATION OF CUTTERS.

It is interesting to note that the Volga dredge was constructed for electric propulsion and operation. Each half was equipped with an independent electrical installation consisting of a 600 kilowatt dynamo direct connected to a triple expansion engine. The current from these generators operates two bow motors of 125 horsepower each, and two stern motors, each driving a 4-foot screw propeller. The electric generators also operate two motors of 30-horsepower capacity, arranged for controlling the position of the pontoon line, although the lighting is done by a separate electric plant. The control of all the electric motors is centralized in the pilot house, where the panel switchboard, rheostat, compensators and other electric appliances are installed. There is also an electrical projector or searchlight mounted above the pilot house for night work, arranged to be controlled from below, so as to be easily directed wherever desired.

Each generator is driven by an engine of the vertical marine triple expansion type, with three cylinders working on three cranks. The stroke is 24 inches, and the high-pressure cylinder measures 14¼ inches in diameter, the intermediate cylinder 22¾ inches, and the low-pressure cylinder 37⅜ inches. Each engine develops 800 horsepower operating at a speed of 200 revolutions per minute and weighs about 25 tons.

Steam is supplied from marine boilers of the watertube type,

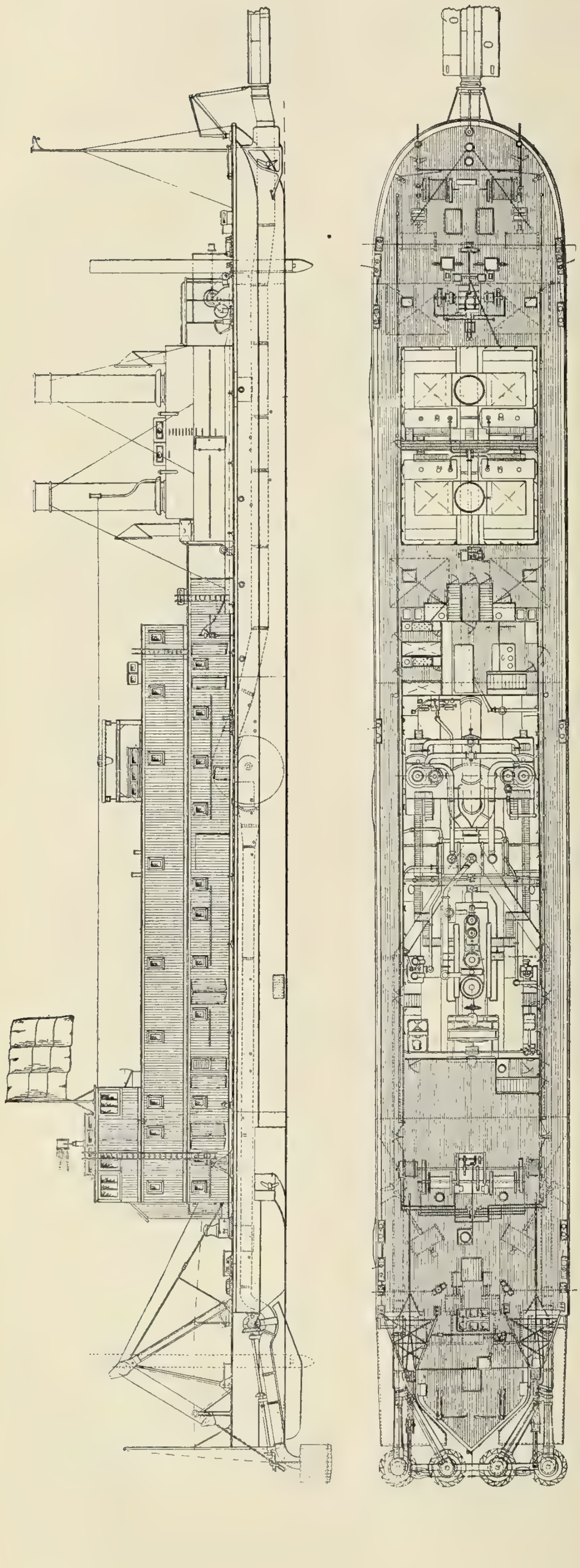


FIG. 2.—OUTBOARD PROFILE AND DECK PLAN OF BATES DREDGER, SHOWING LOCATION OF PUMPS AND PROPELLING MACHINERY.

a battery of four boilers being provided in each hull, making a total of eight, with a heating surface of 17,200 square feet.

The main centrifugal pump is driven by a divided triple expansion engine of 1,425 horsepower operating at a speed of 180 revolutions per minute. Each hull is built entirely of steel, and near the bow are recesses for the suction ladders and their bearings. The pipe pontoons are elliptical air jackets, reversible, and said not to be easily affected by currents, waves or wind. Metal joints were used, as these do not obstruct the discharge stream as much as rubber connections. There are four cutters actuated by each pair of compound cutter engines.

The propulsion of the dredge is accomplished by screws, driven by electric motors, the system adopted being three-phase alternating current. The 600-kilowatt electric generator in each hull is of the 24-pole General Electric type, operating at a pressure of 550 volts. These generators each take 800 horsepower, and at a speed of 200 revolutions per minute supply a current having a frequency of forty periods per second. The four motors of 125 horsepower each on the dredge, and the two on the end pontoon supplied with current from these generators, are of the 12-pole type, operating at a speed of 400 revolutions per minute. Each motor drives a four-bladed propeller, two at the stern and two well forward in the recesses of the hull. The two pontoon motors are of the 10-pole type, having a capacity of 30 horsepower each, and operating at a speed of 480 revolutions per minute. Each of these motors has its rotor shaft directly coupled to propeller shafts carrying three-bladed 20-inch screws.

The large motors have collector rings and external variable resistance in the armature circuit. The cooling system for this resistance is of interest. The wire is wound on an insulated copper pipe 42 feet long for each motor carried on a frame on 5-foot lengths, with fittings at the ends of the pipe. An electrically-driven rotary pump forces through this pipe 15 gallons of water per minute and in this way keeps the temperature of the resistance wire within the proper limit. A separate rheostat of this type is provided for each of the four large motors.

DESIGN OF HULLS FOR HYDRAULIC CUTTER DREDGES.

BY E. N. PERCY.

The design of hulls for sea-going dredges of both the older types and of the newer, Fruhling, system is fairly well standardized; particularly as this class of machine is built very much like a steamship; in fact many of them are converted steamships.

The hull of the cutter or inland type of dredge is open to discussion and improvement, hardly any two being alike in design and bracing, and all, so far as observed, lack some desirable feature of strength or form. Ordinary scow construction is wholly inadequate, as, besides carrying the load of machinery, etc., the hull is subject to tremendous racking strains, which should be analyzed and provided for. Furthermore, the disposition of the machinery and the construction of the ladder does not permit of scow construction. The present form of dredge is often built like a box, braced with bridge trusses; without knees, longitudinal keelsons, or other accepted methods of shipbuilding; and such construction has never failed to give trouble. Steel dredges, while stiffer, cost a great deal to maintain, are noisy, and more easily damaged by grounding or collision. Still, on account of their stiffness and compactness, there are many arguments in their favor.

To consider the various requirements of a dredge hull, one must analyze the work to be done. In the matter of draft, it

is well, on the one hand, for them to be as shallow as possible, as many large remunerative contracts call for a machine of less than 8 feet draft; and many small contracts require less than 5 feet. On the other hand, that the dredge may be towed from place to place, and be seaworthy, it is advisable to have more draft. The breadth should be kept down to allow of contracts for narrow canals and channels, yet for seaworthiness it must be fairly large. The length seems to be about the only dimension in which there is some latitude, but this must not be extreme, because of strength, and the possibility of working around sharp corners in narrow channels.

Their general strength fore and aft is a plain problem of hull design, as is also the strength of decks, laterals, etc. Too many dredges are designed by civil engineers or bridgemen, with the result that mistakes and defects develop which would not have been made if an expert marine hull designer had handled the job. A dredge hull should be constructed along marine lines, with its own special bracing, and not like a box or a tank or a bridge, without knees, keelsons, frames, scarfed joints or other recognized methods of ship carpentry and construction. The particular points of stress to be handled very carefully are the foundations under the machinery, the thrust of the ladder, the bending moment of the ladder length, tending to shear the dredge or distort it around a longitudinal center, the twisting moment of the ladder, the strains exerted by the winding machinery, the strains around the spuds and the towing bits for towing at sea.

A pit is usually made for the pump and engine, or if the engine is belted, for the pump alone. This pit is boarded up on all sides to the water level to prevent the sinking of the dredge in case the pump bursts or leaks badly.

In regard to towing ability and seaworthiness, some note must be taken of the stability, freeboard and strength of housing. The hull should be either pointed or flared forward, and provision made for positive support of the ladder in a heavy seaway. Also, some provision should be made for draining and pumping while at sea.

The choice of materials is the first thing to decide. A steel hull costs from 30 to 40 percent more than a wooden one of the same size. It is stronger and longer lived, but requires great care and frequent docking. It has been suggested to use a composite hull with a steel frame and wooden planking or sheathing. This has never been tried except with steamships, but seems to work very well in their case.

In taking care of the various special strains, there must be provision for each, not a general heterogeneous, hit-and-miss bracing. Under the boilers, engines and pumps should run continuous stringers or keelsons. These should not be stopped at the end of the machinery space, as the hull will develop a weak point there. They should extend from stem to stern, either as part of the hull or built up on the bottom frames.

In the writer's opinion, no machinery should be on the upper deck, except light self-contained apparatus, such as tools, electric light plant, etc. Main engines or winding machinery placed there tend to distort the hull, open seams and cause vibration that would not occur if they were on heavy bedplates resting on the keelsons or frames. As the winding machinery is obliged to be on a level with the deck, the least that could be done would be to connect it rigidly to the bottom of the dredge with structural work or a bedplate, instead of putting in a few stanchions.

The thrust of the ladder is equal to twice the greatest pull exerted by the winding drums and should be distributed by girders extending from the ladder supports to all parts of the hull, taking care that it is not concentrated on any one point. These same girders should be attached to the winding gear bedplate, with ample provision for thrust fore and aft of the bedplate. The side bending moment of the ladder is a maximum when the two spuds are down, and the moment is from the point where the cable leaves the cutter sheave to go ashore to the center of either spud. It tends to distort the hull between the spuds, and has been known to split it wide open. As can be seen, the moment is large and the condition can easily occur. The lateral flexure of the hull is not an important item in ordinary designs, but the strain between the tow spuds is best taken care of by connecting them with two girders, lying in the plane of the upper and lower decks respectively, and connecting these girders to the two vertical girders extending from the foot of the ladder. The placing and bracing of towing bits is too well known to need description.

In many respects there is no reason why a dredge should not follow the lines of steamship design. Few have adequate drainage apparatus, and their hulls deteriorate accordingly. Usually a siphon or two and a pipe from some pump are the complete outfit. If the space between frames cannot be drained, it should be filled up with wood or cement, and a regular drain pump sucking from carefully built sumps put in. The frames often decay first, because of being alternately wet and dry. As the ladder and headframe are very heavy, also the end of the hull containing the cutting and winding gear, lever house and suction pipe, the displacement is considerable, and to maintain trim, two branches or extensions of the hull run out alongside the ladder.

The ladder consists of two heavy I-beams, connected by saddle plates. Under the plates is the suction pipe. Above it the shaft to the cutter. The construction is tapering. At the end is the cutter and suction head. At the upper end are the trunnions in which the ladder sits. Usually the suction pipe turns in through the center of this trunnion, revolving with the ladder in a stuffing box; but some makers, particularly for small dredges, use a ball joint or flexible piece of hose leading in a straight line to the pump. Through the center of the other trunnion comes the drive shaft from the cutter engine. Many dredges place the cutter engines directly on the ladder, connecting pipes with ball joints. It is open to discussion as to which is the best method. The ladder is supported by a tackle, sheaves being at two or three points on the ladder to reduce flexure and keep the cutter shaft in line.

The frame over the ladder for lifting it, and the method by which its strains are distributed to the hull, is an important hull detail. In small dredges it may be a simple A-frame or shear. In larger ones, with a long heavy ladder, and hoisting sheaves at two, three or four points, it assumes some of the complications of structural engineering. Usually the frame rests on the fore-and-aft girders, and should have considerable bearing area, as the ladder at one end, boilers at the other, and the upward component of buoyancy act on the dredge with a definite bending moment to produce flexure.

Few lever rooms are designed correctly. The levers should be self-contained, whether connected or not. The throttle of the cutter and winder should be placed so it can be used while watching the cutter board. The windows should be very low, not higher than 2 feet from the floor, so the operator can stand well back and still see the ladder. Instead of a gong, the best dredgers now have regular telegraph to the engine room, and telephone connection with the pipe-line crew. Instruments for sighting are provided, showing instantly the angle of swing and width in feet. Several instruments showing the position of the cutter have been invented, but are not, as yet, very reliable. The lever room should have windows on all sides, as the operator should be able to see, not only his ladder, but the spuds, the pipe line, the bank, approaching craft, the weather, and anything else tending to keep him properly informed.

Many dredges still provide quarters for the crew on board, but it is a poor place to live, on account of the noise and dirt,

and most firms now use a separate boat to house the men. Among the details to be provided for, or at least considered, are boarding ladders, fire protection, boat davits, chocks and bits for scows, tugs, etc., coal and ventilation hatches, ladders and gratings. It is becoming customary to provide an auxiliary engine room for all auxiliaries, instead of distributing them all over the dredge. This includes feed pumps, air pumps, circulating pumps, bilge pumps, water-service pumps, dynamo engine, cutter engine and oil pumps. The winder engine, of necessity, is on deck. Provision must also be made for electric wiring, as electric lights, and in some cases electric auxiliaries, are becoming a greater necessity every day. Searchlights and arc lamps are used on the more advanced designs. Incandescent lights are used on small dredges, but are inadequate, as a rule, because they are so irregularly operated. Tanks for fresh water, feed water, wash water, oil, waste and grease must be provided. Painting specifications should be as carefully written as for a steamship hull.

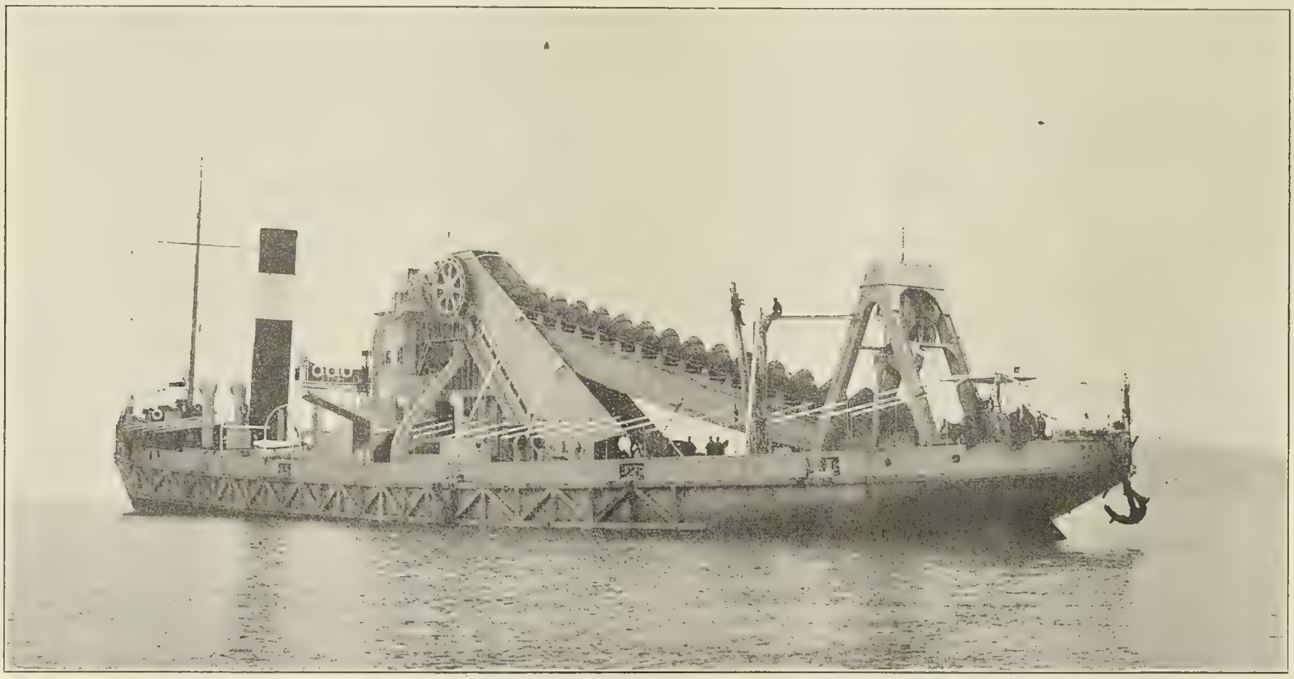
AN EIGHT-YARD DIPPER DREDGE FOR THE CUBAN GOVERNMENT.

A large dipper dredge, which involves some novel features, was built by the American Locomotive Company for the Cuban government and delivered in the harbor of Havana in December, 1907. The dredge was built and erected complete and in working order (with the exception of the deckhouse) in the James River, at Richmond, Va., and tested under steam. Upon the conclusion of the test the A-frame, boom, spuds, etc., and all external parts were dismounted and securely stowed on board, and the dredge made ready for sea. It was then towed to Havana without mishap, and the external parts re-erected.

The hull is of steel 125 feet long with a beam of 42 feet and a depth of 12 feet at the bow. It is built in a very substantial manner, and stiffened internally with two longitudinal steel trusses, which do not, however, extend above the level of the deck. The truss is built into the hull in such a way that the steel deck forms part of the strength of the top chord of the truss, and, in fact, all the strength of the hull is in its main body, no headframe or other superstructure being used for the support of any of the working parts.

The boom is of steel, 44 feet long and of massive construction. It is of the Robinson patent type, having a straight taper and a steel turntable, built solidly with the base of the boom. This type of boom has now been in service on several dredges for a number of years, and it is claimed has given good satisfaction. It has the advantage of simplicity and strength, while the swinging power is applied in the most effective way.

The hoisting machinery consists of a main engine, having cylinders 17 inches by 20 inches, double geared to a conical drum. The main hoisting is on the parallel system. The two ends of the single length of rope are attached to the opposite ends of the drum in such a way that the fastenings are readily accessible, while the middle of the rope is equalized around a thimble at the dipper. In this way each of the two parallel parts of the rope bears half of the load at all times. The main sheaves are of cast steel, 8 feet diameter with double grooves. This method of hoisting is a great improvement over the earlier type of direct wire rope hoist in which a



THE PELUSE, LARGEST SEAGOING BUCKET DREDGE AFLOAT.

THE BUCKET DREDGE PELUSE.

What is said to be the largest bucket dredge afloat has recently been delivered by Lobnitz & Company, Ltd., of Renfrew, to the Suez Canal Company, Port Said. The *Peluse* is a twin-screw, seagoing dredge, 305 feet long over all, with a molded breadth of 47 feet and a molded depth of 20 feet 2 inches. The hull is amply sub-divided by watertight bulkheads to render her practically unsinkable in case of collision. The vessel is classed by the Bureau Veritas in their highest class. A steel deck, sheathed with teak, is fitted throughout, and there is a raised forecastle at the bow and raised poop at the stern.

The main propelling engines have a total indicated horsepower of 1,800, and the separate dredging engine 600. The latter is of the three-crank design, placed on the main framing. Steam is furnished by three Scotch boilers, each 15 feet diameter and 10 feet 7½ inches long. Hydraulic power is used for all the auxiliary machinery and Lobnitz patent hopper door arrangements are fitted. A separate condensing plant is fitted for all the machinery. The dredging depth of the vessel is between the limits of 20 and 50 feet below the water level.

TYPE OF DREDGE BUILT BY THE AMERICAN LOCOMOTIVE COMPANY FOR THE CUBAN GOVERNMENT.

single rope of large size is used. Wire rope for hoisting on dipper dredges has now practically entirely superseded chain on account of its smoothness of working and efficiency, and also because it does not break without warning, as is the case with chain.

The first dredge of considerable size having a direct-wire rope hoist was built in 1890 from Mr. Robinson's designs, and has since been largely used. The use of the single-wire rope is, however, attended with the disadvantage of lack of durability, as the life of such ropes is usually not more than four to eight weeks. Even with such short life, however, the rope is preferred to chain, and under the improved system here adopted the full advantage of the rope is retained, while the durability is greatly extended. The length of life of the ropes

LADDER AND DIPPER OF 8-YARD DREDGE.

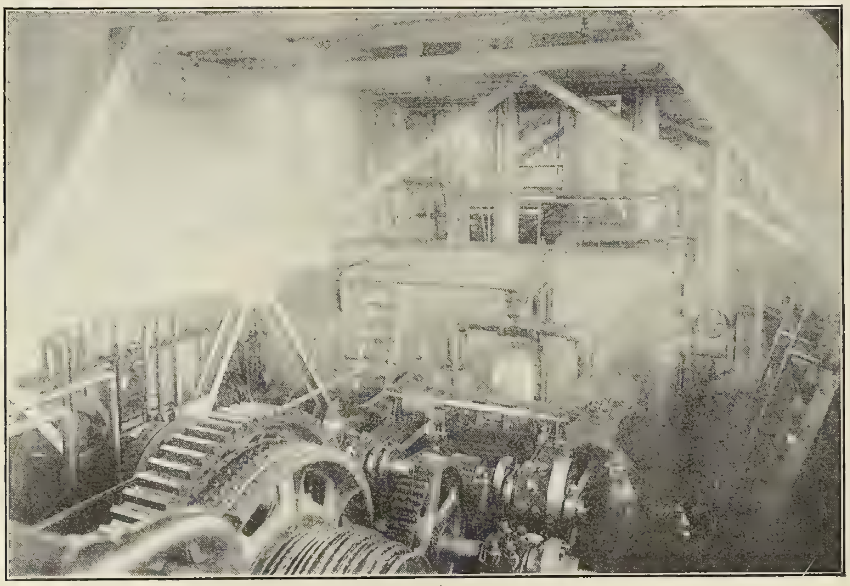
under this new system has not yet been determined, as the dredges have not been in service a sufficient length of time to require renewal. It is known, however, that under this system the ropes, when of proper quality and with machinery of proper design, will last at least a year.

The next important improvement which has been made is in the spuds. These are of steel, 40 inches by 40 inches, and are of special design. Many experiments have been made with steel spuds, but up to the present time they have proved less satisfactory than wooden spuds, owing to their lack of elasticity and to the difficulty of withstanding the enormous concentrated stresses in the riveted members. When the dipper dredge is working in fairly deep water, the stresses on the spuds are very severe and concentrated at the point of support, so that it has been practically impossible to avoid shearing of the rivets or buckling of the members. This is especially the case where steel spuds are used in connection with a steel hull. Recognizing the necessity for elasticity of connection and the distribution of the stresses over a sufficient length of spud, a simple system of cushion supports has been adopted which has proved to be very successful in service.

The swinging engines are located on the main deck, with rope leading directly to the turntable, and have 9-inch by 9-inch cylinders double geared. These engines, with the proper ratio of gearing, give ample swinging power under all conditions.

The boiler is of Scotch marine type, 11 feet 6 inches diameter by 11 feet long, and furnishes ample steam for the dredge with natural draft. The dredge is fitted with all usual auxiliaries, including surface condensation, electric light, hand and steam capstans, as well as commodious crew's quarters. Special attention has been paid to ease of operation, so that the full work of the dredge can be maintained in the warm climate without fatigue to the operator. With this end in view all the important motions are operated by steam, and the dredge, as a whole, including the spuds, is under the direct control of the engineer.

The dredge is named the *Cayo Piedra*, and was furnished by the Atlantic Equipment Company, of 30 Church street, New York, to the order of Mr. Lombillo Clark, of Havana, Cuba, for the Department of Public Works. The dredge was designed by A. W. Robinson, M. Am. Soc. C. E., and built under the supervision of Mr. José Primelles, engineer for the purchasers.



MACHINERY SPACE OF THE CUBAN DREDGE.

MONSTER BATTLESHIPS.

BY SIDNEY GRAVES KOON, M. M. E.

When England set the pace, in 1905, with the now classic *Dreadnought* of 17,900 tons, the leading naval powers were building battleships of 16,000 to 16,600 tons displacement as a maximum. Sizes had very gradually advanced to that figure from the 14,150 tons of the *Royal Sovereign* class, built under the (British) Naval Defense Act of 1888. In the first four years of the *Dreadnought* era, however, such has been the impetus given design by that famous ship that displacements have advanced to 19,000 tons in the Italian *Mirabello* and German *Ersatz Beowulf;* 19,250 tons in the Brazilian *Minas Geraes;* 20,000 tons in the American *North Dakota;* 20,250 tons in the British *Neptune;* 20,750 tons in the Japanese *Huki* and Russian *Peter Veliki;* and now a bill has been passed by the United States Congress providing for the construction of two vessels of 26,000 tons each, at an estimated finished cost per vessel of $9,500,000—no more than the estimate of two years ago for the 20,000-ton *North Dakota*. Very little information is available concerning the design forming the basis of this bill, beyond the fact that it calls for a sea speed of 20½ knots, and a main battery of eight 14-inch guns,* presumably mounted in pairs in four turrets on the center line, as with the 12-inch guns on the 16,000-ton battleship *Michigan*.

If we assume that the *Michigan* has been taken as a basis of departure, and the whole vessel expanded, as have been the main battery guns, in the ratio of the cube of 14/12, we find a marked resemblance between the figures for the new vessel and those for the expanded older ship. Thus, this ratio of 343/216, applied to the displacement of the *Michigan*, gives 25,407 tons, or only slightly less than the displacement of the new design. Let us examine a table of weights based on those of our type ship:

* One account says twelve 12-inch 50-caliber guns, mounted in pairs in six turrets on the center line, all bearing on either broadside.

	Michigan.	*A.*	*B.*
Hull and fittings (*a*)	7,469	11,860	12,140
Equipment and 2/3 stores (*b*)	823	1,307	1,250
Machinery and water	1,643	2,609	2,250
Normal coal supply	900	1,429	1,400
Battery and 2/3 ammunition	1,118	1,775	2,460
Armor and backing	4,047	6,427	6,500
Displacement	16,000	25,407	26,000

(*a*) Includes protective deck. (*b*) Includes officers, crew and effects.

The figures in the first colum represent, in tons, the weights of the principal component parts of the displacement of the *Michigan*. The second column shows the same figures expanded in our ratio of 343/216; while the third is obtained from the second, as will be explained.

The *Michigan*, with 16,500 indicated horsepower, is expected to develop a speed of 18.5 knots. This accounts for an

$$\text{Admiralty coefficient}\left(\frac{(\text{displacement})^{2/3}\times(\text{speed})^3}{\text{horsepower}}\right)$$

of 244. With a hull exactly like that of the *Michigan*, except for size, the ship *A*, with 26,200 horsepower—the same power per ton of displacement—(as accounted for by the same proportionate weight of machinery) should show a speed of 19.5 knots. For the speed to reach 20.5 knots the horsepower would require to be increased to 30,500. But with the larger hull would come increased relative ease of driving at high speed; and if, as must certainly be the case (as explained later), the relation between length and beam be largely increased, a still further small reduction in horsepower required might be expected. Hence it is safe to assume that 30,000 indicated horsepower, or its equivalent (say, 28,000 shaft horsepower, delivered by turbines), would drive the 26,000-ton vessel at a sea speed of 20½ knots. This would call for an Admiralty coefficient, based on shaft horsepower, of 270, as compared with 273 for the *North Dakota* with 25,000 shaft horsepower and 21 knots. The turbine machinery of the *North Dakota* weighs 1,923 tons; on the same basis, turbine machinery of 28,000 shaft horsepower would weigh 2,154 tons. Allowing 96 tons reserve feed water (the *North Dakota* and *Michigan* carry only 66 tons), our machinery and water figures out 2,250 tons, as shown under ship *B*. This great reduction in machinery weight is due to the use of the steam turbine.

The equivalent indicated horsepower of *B* at 18.5 knots—the speed of the *Michigan*—would be 22,000. For this speed, 1,200 tons of coal in the new ship would provide for the same steaming radius as the 900 tons which the *Michigan* carries on normal displacement. It is advisable, however, to increase this figure to 1,400 tons, as shown in the table, giving a radius abut 17 percent in excess of that of the *Michigan*—always assuming that the power is obtained on an equivalent expenditure of fuel per horsepower per hour.

The crew of a large ship is smaller in proportion to the size of the ship than is that of a smaller ship. This fact, affecting a number of items under the general heading of equipment and stores, would permit a reduction of that figure to 1,250 tons; which ought to permit the carrying of nearly or quite a full supply of stores.

The *Michigan* has a secondary (anti-torpedo-boat) battery of twenty-two 3-inch guns. The expanded ship *A* would allow for twenty-two 3.5-inch guns. These are too light for effective work at the range of the latest and most powerful torpedoes. Six-inch guns should be used (the *North Dakota* carries fourteen 5-inch guns); and it is by no means certain that 7-inch guns would not be more satisfactory. Both the 6-inch and 7-inch weapons are very handy, rapid of fire and sufficiently powerful for the work; but the 7-inch would have a decided advantage in attacking light armor at battle ranges. A battery of twenty 7-inch guns could be provided, with 200 rounds of ammunition per gun, on a weight of 860 tons for guns, mounts and ammunition; while the 3.5-inch guns which they replace would weigh 175 tons. This accounts for an addition of 685 tons to battery weights, bringing the figure up to 2,460 tons. If we decide on a secondary battery of 6-inch guns, we find that thirty-two may be installed on the weight of the twenty 7-inch guns. This would furnish an enormous volume of anti-topedo-boat fire.

WEIGHT OF BROADSIDE IN POUNDS.

	Main.	*Secondary.*	*Total.*	*Per Ton.*
Ship *B*, 7-inch guns	11,200	1,980	13,180	0.507
Ship *B*, 6-inch guns	11,200	1,890	13,090	0.503
Ship *A*	11,200	296	11,496	0.452
North Dakota	8,700	420	9,120	0.456
Michigan	6,960	154	7,114	0.445
Connecticut	3,480	2,156	5,636	0.352
Dreadnought	6,800	192	6,992	0.391

The various changes which we have made in passing from ship *A* to ship *B* have resulted in a slight increase in the weight available for armor—no more than would be necessitated for additional hull armor to cover in equal proportion the side of the larger ship—leaving the schedule of thickness the same for *B* as for *A*. But it should be noted that, on our original assumption of an expansion in the linear ratio of 14 to 12 from the design of the *Michigan*, this expansion, if we cover the same proportionate area of the side of the ship, will affect the thickness in that same ratio. Thus, the main belt armor may be made 14 inches thick, maximum, in place of 12 inches; the upper belt 11 2/3 inches in place of 10 inches; the barbette armor 11 2/3 inches in place of 10 inches; the turret armor 14 inches in place of 12 inches front, and 9 1/3 inches in place of 8 inches rear; and the deck armor 3½ inches in place of 3 inches. It is probable that, in developing the design, slight reductions would be made in some, if not all, of these figures, with corresponding extension of the area covered by the armor protection.

By accepting the same schedule of thickness as on the *Michigan*, and covering the same proportionate areas, we find that the requirements for armor would be $4{,}047 \times (^{14}/_{12})^2 =$ 5,509 tons only, in place of 6,427 tons. Making some allowance for the increased proportionate length of the new ship, as compared with the *Michigan*, the figure may be tentatively set at 5,700 tons. This leaves 727 tons for additional armor, or additional battery, or increased fuel supply, with consequently augmented steaming radius, or greater engine power, with correspondingly increased speed.

The armor schedule could be increased in thickness an average of 12½ percent, or correspondingly increased in area covered, or both could be increased 6 percent.

Or, as a pair of 8-inch guns, with mounts, turret, armor and ammunition calls for about 180 tons, eight such guns, in four turrets, could be provided.

Or the steaming radius could be increased 50 percent.

Or the shaft horsepower could be increased by 11,000, involving a probable increase in speed from 20½ knots to 22½ or 23 knots.

As to dimensions, those of the *Michigan* are 450 feet length on waterline, 80 feet molded beam, and 24 feet 6 inches mean draft at her normal displacement of 16,000 tons. Our expanded ship would have a length of 525 feet, a beam of 93 feet 4 inches, and a mean normal draft of 28 feet 7 inches. Her block coefficient would be the same (0.635) as that of the *Michigan*. But a beam of 93 feet and more would bar the ship from almost every drydock in the world. Even 90 feet beam would have this effect, in only slightly lesser degree. If we fix the beam at 88 feet, as in the *Lusitania*, the results are

somewhat better. With the same draft and block coefficient as before, this calls for a length of 557 feet. Such an increase in length would require small additions to structural weight of hull. These additions might be partially reduced by increasing the depth of hull (and draft of ship), thus making a potentially stronger girder. In order to do this without adding displacement, the lines could be made finer, and this would have the added beneficial result of aiding propulsion. The *Michigan* was benefited by this "fining" of the lines, as compared with the earlier *Connecticut,* of the same size and power; the speed being increased ½ knot by the process. With a length of 560 feet, beam of 88 feet, and draft of 30 feet, the block coefficient would be 0.616, as compared with 0.661 for the *Connecticut,* 0.635 for the *Michigan,* and 0.598 for the 21-knot *North Dakota.* Exception will be taken to a draft of 30 feet, because of the shallowness of many of our harbors, but with a ship of such size it cannot well be avoided. This draft is exceeded by a few foreign warships, and by many of the largest trans-Atlantic liners.

The matter has been gone into thus in detail, partly to indicate the character of the general problem before the designer of such a ship, and partly to show what enormous power can be concentrated in such a large ship, and how mere size is in itself a most valuable asset.

THE LOBNITZ PATENT ROCK BREAKER.

Subaqueous excavation of rock is usually accomplished in one of two ways, either by the use of explosives or by some form of rock breaker, operated from a dredge or float. The use of explosives usually leaves the broken rock in large pieces, which are difficult to remove by the ordinary methods of dredging. Mechanical rock breakers, on the other hand, tend to pulverize the rock or break it into smaller pieces of uniform size, which can be handled by a dredger as easily as mud, silt, or sand.

In the Lobnitz patent rock breaker the work is done by means of a heavy chisel, which is allowed to fall freely by its own weight on to the rock. As the whole force of the blow is concentrated on a very small surface, the tempered point of the rock cutter easily crushes the hardest kind of rock. The general arrangement of this rock breaker is shown in the photographs. The chisel is of pressed steel, weighing usually from 10 to 15 tons, and it is fitted with a hard-cutting point, called the cutter, by means of which the rock is broken. With a drop of from 6 to 10 feet, the cutter breaks its way into the surface of the rock, partly pulverizing it and partly breaking it. The cutter delivers blows on the same spot until it has penetrated about 3 feet into the rock. If the thickness of rock to be broken is more than 3 feet, it is customary to break it in horizontal layers, each about 3 feet thick. As soon as one layer is broken, the loose material is removed by means of a dredger before breaking up the next layer. After the cutter has been dropped on the same spot until the desired penetration is obtained, the barge on which the cutter is

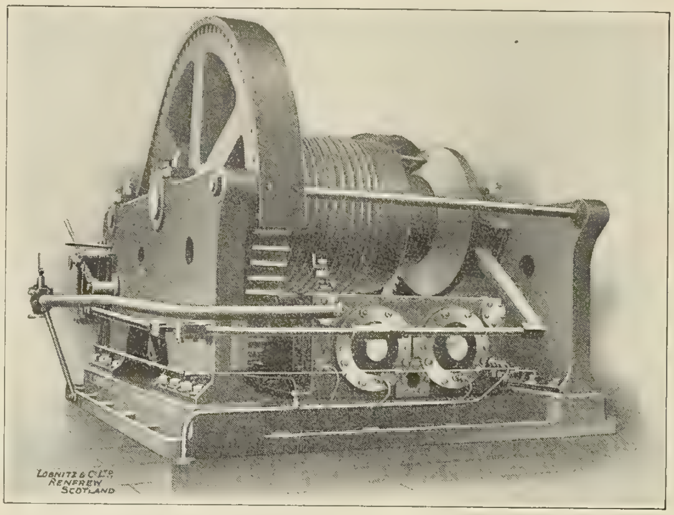


FIG. 2.—HOISTING WINCH, USED ON LOBNITZ ROCK BREAKER.

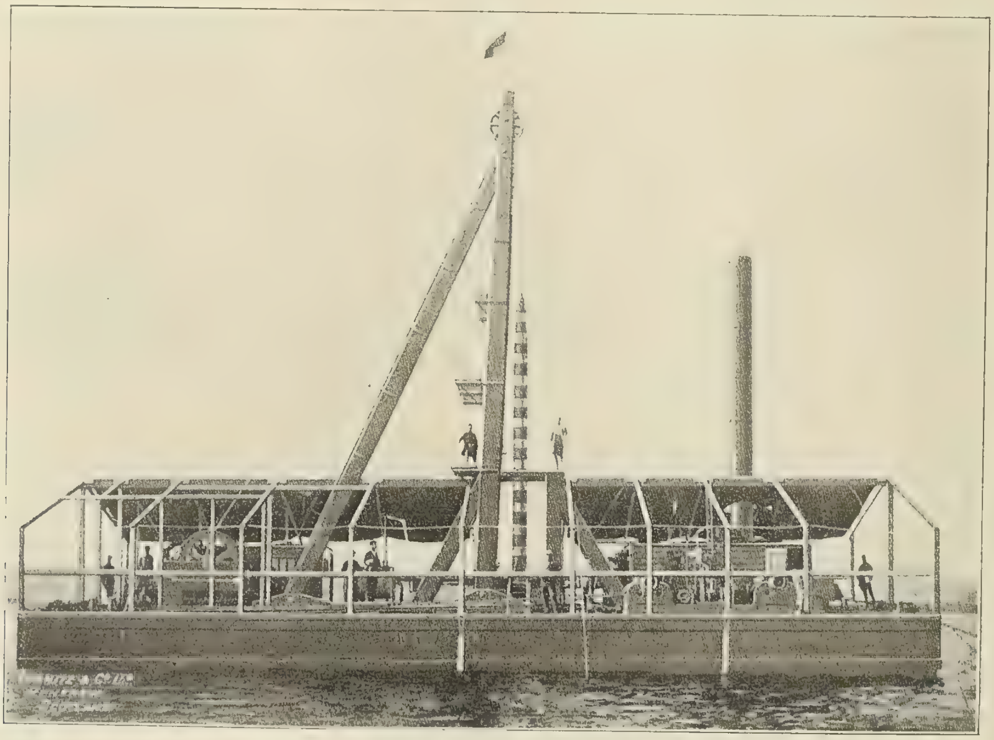


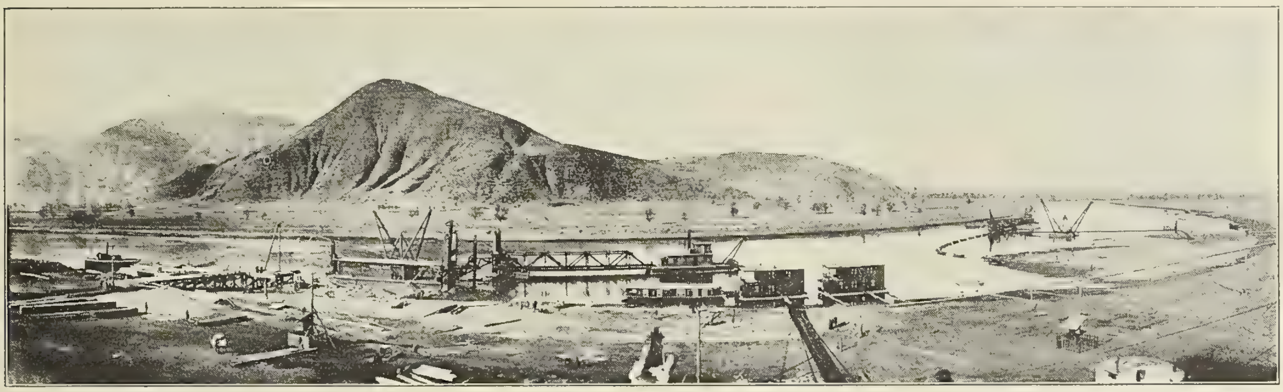
FIG. 1.—A SINGLE CUTTER LOBNITZ ROCK BREAKER.

mounted is moved a distance of about 3 feet. This is done by means of six maneuvring chains or wire ropes, which are worked by a special steam winch, designed to insure accuracy of maneuvring. The number of blows needed to penetrate the rock to the desired depth, and the distance through which it is necessary to move the barge between the spots where the blows are struck, varies with the kind of rock which is being broken; these details being settled by experience. From ten to twenty blows are usually required on each spot to penetrate a layer 3 feet deep.

The hoisting winch, shown in Fig. 2, is a powerful steam engine with suitable gearing and special fittings for continuous running. About 1,500 blows per day of 10 hours are given in regular work. The winch is so arranged that with a lubricated steel friction clutch and automatic gear, the wire rope follows the fall of the cutter and raises the cutter again immediately after the blow has been struck. A feed pump is worked from the winch, which feeds the boiler in proportion to the amount of steam used. The feed water is preferably fresh water taken from a tank on the barge, although, of course, sea water may be used, provided the fireman understands the operation of a marine boiler with salt water. A feed-water heater, heated by the exhaust steam, is also provided.

The cutting points of the chisels are removable, so that a point best adapted for the quality of rock to be cut can be used. The points are made harder in the center than on the outside, and they remain automatically sharp if the rock is of an abrasive nature, such as sandstone. Steel similar to that used for armor-piercing projectiles is the material used for the points. When removing a cutter point from the chisel, the cutter is hoisted to a suitable height above the deck; logs are laid over the well and the screws are taken out of the end of the cutter. The end of the cutter just above the hoop is then given a sharp heat by means of two portable, pressure oil lamps. Wedges are then driven between the hoop and the point in spaces provided for this purpose, and the point is forced out. The hoop, which is still hot, is then easily knocked off by hammering around the projecting edge. A new hoop, heated to a red heat, is then shrunk on the end of the chisel, and while the cutter is still hot, it is lowered on to the new point, the shank of which has been previously greased. The weight of the cutter is sufficient to press the point home. The screws are then carefully greased and replaced, the whole operation of changing points taking from 2 to 3 hours.

These rock breakers are built in sizes having cutters weighing from 6 tons upward, capable of working at any depth and in rock of any kind. The apparatus can be made self-propelling if desired. The expense per cubic yard of average rock broken, ready for convenient dredging, may be estimated approximately by the following rule: A single cutter machine will break up per day in average rock 100 cubic yards for 1 ton of coal and the wages of four men. The cost of oil, stores and repairs, it is claimed, does not exceed the outlay for coal and wages. An average performance for one of these breakers working in hard rock is 2 cubic feet of rock broken per blow, and an average of 150 blows can be delivered per hour, making the capacity of the machine 10 cubic yards per working hour for a single-cutter machine. The machines are also made with double cutters, and the capacity is then about one-half more than with a single cutter. A crew of four men is required on single cutters, and six men on a barge with two cutters. The average coal consumption for a working day of 10 hours for a single 10-ton cutter is 1 ton, and for a two-cutter machine 1½ tons. The consumption of fresh water is estimated as about five times the weight of the coal used.



VIEW OF DREDGING OPERATIONS AT KASHMIR, IN THE HIMALAYA MOUNTAINS.

A DREDGING EQUIPMENT IN THE HIMALAYA MOUNTAINS.

An interesting dredging plant, designed by the Bucyrus Company, South Milwaukee, Wis., is now operating in the Vale of Kashmir, a British principality in the Himalaya Mountains in India. To transport this machinery to its destination, it was necessary to haul it in bullock carts for 200 miles, from Rawalpindi to Baramula. A range of mountains 8,000 feet in height had to be crossed, and it was necessary to so design the dredges that no piece when ready for shipment should weigh over 3 tons. The plant consists of two 18-inch hydraulic dredges, two clam-shell derricks, and one 4-yard dipper dredge. This machinery is electrically driven by motors of the three-phase type, the electrical equipment aggregating

TOP OF LADDER FOR SUCTION DREDGE, SHOWING CONNECTIONS TO REVOLVING CUTTER.

2,018 horsepower, being furnished by the General Electric Company, Schenectady, N. Y.

The hydraulic dredges are designed to dig to a maximum depth of 25 feet, and to discharge the material at a velocity of 12 feet per second through 450 feet of 18-inch pipe to a maximum height of 20 feet above the water level. The 18-inch pump is especially designed for dredging. The shell and runner are steel castings, and the former has five curved arms and is cast in one piece. The pump is driven by a 350-horsepower motor, to which it is direct connected. The suction ladder carries a revolving cutter head, driven through shaft and gearing from the top of the ladder by a 100-horsepower motor. The cutter head is supplied with curved blades for properly disintegrating the material. The bow winch is driven by a 45-horsepower motor, and consists of two drums for the swinging line and one for hoisting the suction pipe. The stern winch is driven by a 30-horsepower motor and has three drums, two for raising and lowering the spuds and one for the thrust of the walking spud.

The dipper dredge is designed to dig to a depth of 22 feet below the water level. The dipper has a capacity of four cubic yards. The boom is 40 feet long and is of wood. As on the ordinary type of harbor dredges, the hoisting machinery is single-part wire rope. The pinions, gears and drums on both hoisting and swinging machinery are steel castings. The wooden boom is stepped into a cast steel pivot bearing, formed with sockets to receive the boom foot. This pivot rotates on a steel baseplate, separately bolted to the hull. The swinging circle is of structural steel and wood, 18 feet in diameter, mounted on top of the hull. The connection to the boom is made by means of arms extending out over the circle, one on each side of the boom, the center being a heavy steel casting riveted to the circle. The dipper handle is of the combination wood and steel type, with cast steel racks. The spuds are of wood, 36 inches square and 40 feet long. They are fitted with cast steel blade points. The spud drum is operated by a shaft driven from the main hoisting machinery. The stern spud is of wood, 24 inches square and 40 feet long. This spud is so arranged that it can be forced down to a position where it assists the forward spud in holding the dredge while the bucket is digging. It can also be used as a walking spud to move the boat forward when ready to make a fresh cut.

The function of the clam-shell derricks is to unload the material excavated by the dipper dredge from scows and deposit it into the spoil area at a considerable distance from the bank of the river. They are equipped with 80-foot booms, and handle a three-yard clam-shell bucket, which is of the smooth-edge type without teeth and weighs about 7,000 pounds. The derrick is built of wood and is arranged to travel on tracks, the boom mast and swinging circle being supported on ten wheels, running on a two-rail track, the hoisting and swinging machinery being carried on six wheels on the same track. The back leg is anchored on a timber frame, running on four wheels on a single track, parallel to the main track under the hoist and about 45 feet distant from it.

On account of the great distance from the place of manufacture, the machinery was made especially heavy, all gears, drums, pinions and fittings being made of steel castings, which weigh considerably more than those put into dredges of the same size in the United States. The plant has now been in successful operation for about six months, and no defects have been reported.

The programme for the reconstruction of the Spanish navy involves the building of three heavy-armored vessels of about 15,000 tons displacement; three 350-ton destroyers, or three submarines, and twenty-four torpedo boats.

AN AMERICAN TRAMP STEAMER.

A steel freight steamship is being built by the Newport News Shipbuilding & Dry Dock Company for the A. H. Bull Steamship Company, which has the following principal dimensions:

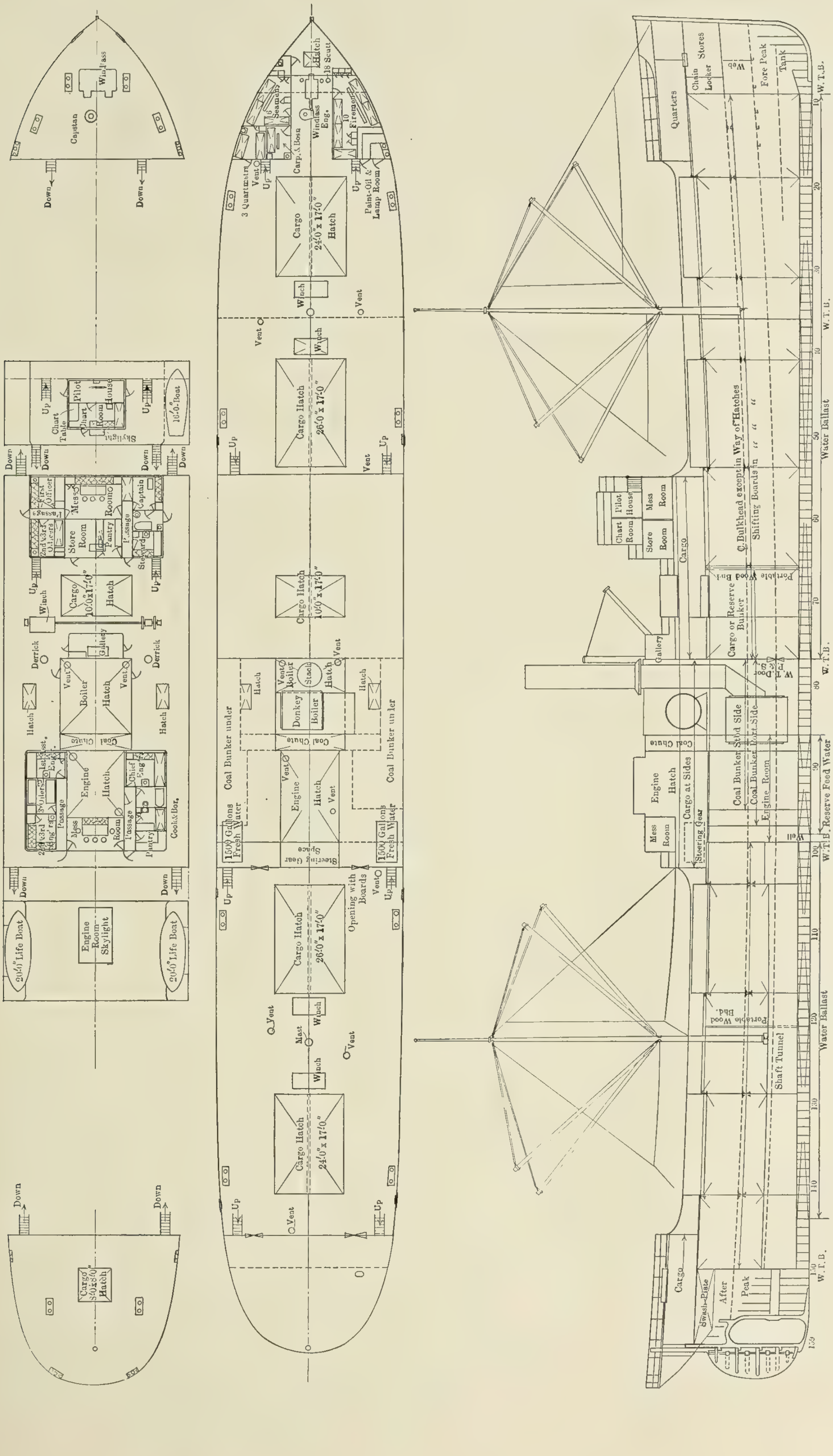
Length over all	329 feet.
Length from aft side of stem to fore side of rudder post	317 feet.
Beam molded	46 feet.
Depth molded	24 feet 3 ins.
Load draft	20 feet.
Deadweight carried on above draft, about	4,600 tons.

As indicated on the accompanying general arrangement plan, the vessel has a single deck, a raised forecastle, long bridge, short, full poop, and is schooner rigged with two pole masts. There are two separate steel deck houses on the bridge deck, a steel pilot house on top of the forward deck house, and a flying bridge at the level of the top of the pilot house. The machinery is located amidships; the two main boilers arranged with an athwartship stokehold forward, and a screen bulkhead dividing the boiler and engine rooms. Side bunkers are fitted abreast the boilers and at the sides of the engine room, the bunkers being filled by a coal chute, located between the boiler and engine casings, with its hatch at the level of the top of the deck house. Additional coaling facilities are provided through small haches in the bridge and upper decks directly over the boiler-room bunkers.

The vessel is divided into compartments by five watertight bulkheads, all extending to the upper deck. These are located at the fore peak, in the middle of the forward hold, forward of the boiler room, aft of the engine room, and at the after peak respectively. The after hold is divided into compartments by a portable wooden bulkhead, and a similar bulkhead is located near the after end of No. 2 hold to provide a reserve bunker, forward of the boiler room. The cargo holds are further subdivided by a centerline bulkhead extending from the tank top to the upper deck. This bulkhead is of steel between the hatches, and in way of the hatches is of wood, made portable. There is one large hatch to each of the cargo holds; all haches having coamings 3 feet 6 inches high. The space under the bridge deck, with the exception of that devoted to machinery casings, is used entirely for cargo, as is also the space under the poop. Portable wooden shifting boards are fitted at the centerline under the bridge deck, extending from the boiler casing to the forward end. The total cargo space is 244,000 cubic feet for bales, and 263,000 cubic feet for grain.

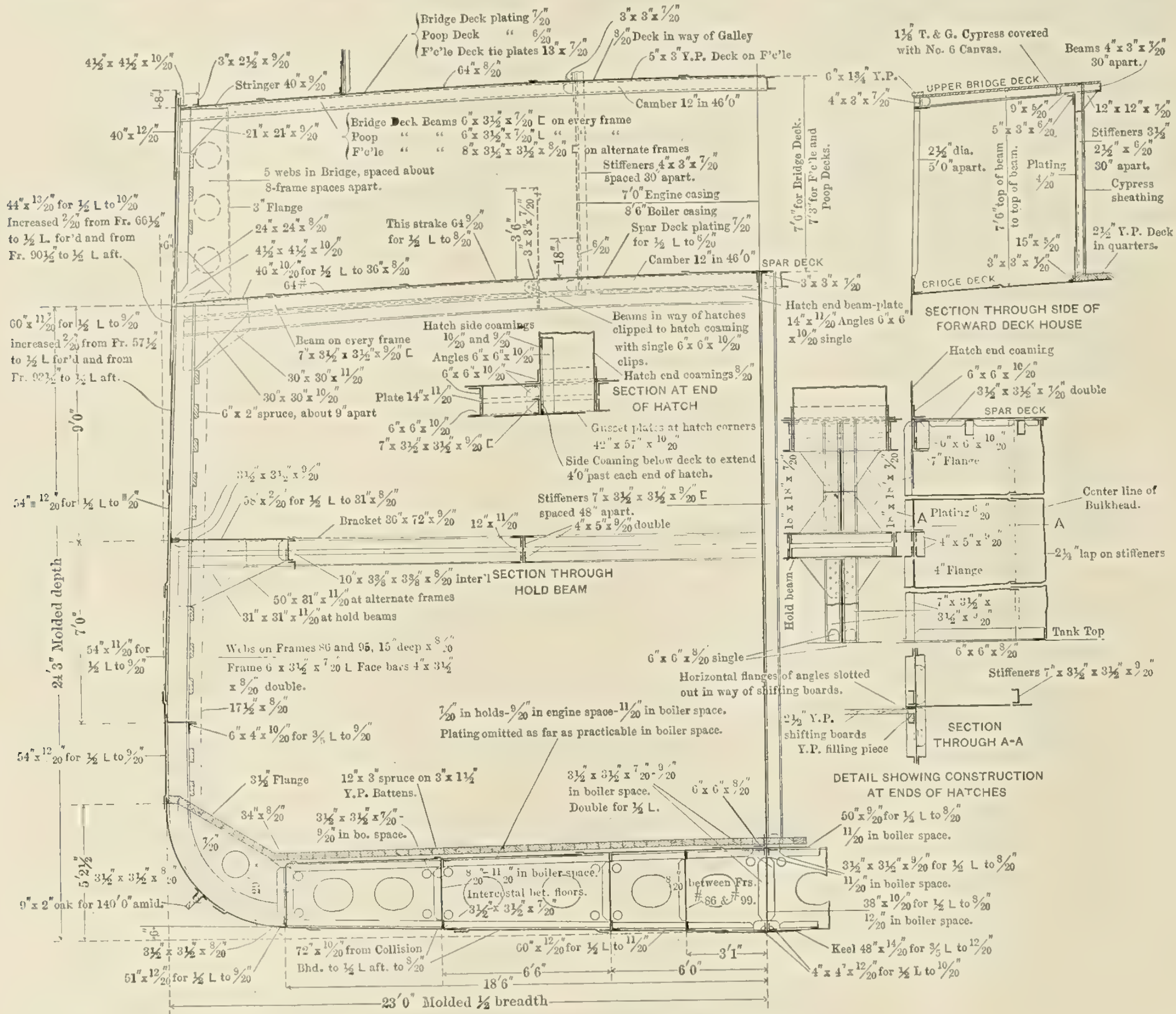
Accommodations for the officers and crew are provided in the two deck houses and under the forecastle deck. The forward deck house contains staterooms for the captain and deck officers, a bath room, officers' mess, pantry and storeroom. The after deck house contains staterooms for the engineers and cooks, a bath room, mess room and pantry. Under the forecastle two staterooms are provided for quartermasters, the carpenter and boatswain; also quarters for six seamen and ten firemen. The galley is located in a separate steel enclosure forward of the boiler casing. The pilot house is provided with a separate chart room, which is also arranged for use as a stateroom. In the captain's quarters the finish is oak; in the other quarters it is cypress.

The general type of construction is indicated on the midship section. The vessel is being built under Lloyd's spar deck rules, with one deck and a tier of wide-spaced hold beams, with a wide stringer fitted on the latter. There is a double bottom throughout, with solid floors on every frame, and two intercostal longitudinals on each side of the vertical keel. Double frames and additional longitudinals are fitted at the forward end. This construction of double bottom was adopted



INBOARD PROFILE AND DECK PLANS OF THE AMERICAN TRAMP STEAMER, BUILDING AT NEWPORT NEWS.

on account of the liability of the vessel being aground at times when loading. Between the peak bulkheads, deep channel framing is used, and in the peaks the ordinary angle and reverse frame construction. In way of the bridge, the frames are cut at the upper deck, and angle-bar frames are used between the upper and bridge decks. The upper and bridge decks are complete steel decks, with channel beams on every frame. At the hatch ends the deck beams are built up of plate and angles. Hold beams are built up of plate, with double angles top and bottom. The centerline bulkhead is stiffened by vertical channels, spaced 48 inches centers. Machinery casings of steel extend to the top of the bridge deck house. Wood ceiling is fitted on the tank top and bilge cork inserts have proved advantageous in that they have double the holding power of wood and engage with a lightness and ease which requires only half the effort on the part of the operator, thus enabling the operator to work his winch much faster, while at the same time saving himself much fatiguing labor. It is also claimed that the cork insert frictions are not affected by either oil, dirt or water. The frictions on all the winches are applied by an internal double cam arrangement and the end thrust on the cams is taken up by roller bearings. The friction levers in the cargo-handling winches are connected to the cams by gear wheels which permit the application of the frictions by a very small movement of the liners. Each drum has a hand brake applied by a



MIDSHIP SECTION OF AMERICAN TRAMP STEAMER.

brackets, and cargo battens on the side frames throughout the cargo holds.

The cargo-handling gear consists of two booms on each side of the fore and main masts, and two derrick posts on the bridge deck with one boom on each. The booms on the masts are from 40 to 46 feet long, and those on the derrick posts 32 feet long. The latter are arranged so that they span the coal hatches as well as the bridge deck cargo hatch. For operating the main cargo booms, four Lidgerwood, double, 8¼ inch by 10-inch winches are provided, each winch having two drums and two gypsy heads, so that two cargo booms can be operated by one winch. At the midship hatch is a special winch for coaling. This will be operated by a single-cylinder engine, 6¼ inches by 10 inches, geared to an extended shaft athwartship, carrying at either end a friction drum and an extra large gypsy head. Each of the friction drums on all of the winches is fitted with the Lidgerwood double cone wood frictions, with patent cork inserts. These foot lever. Hand levers are supplied over on each side of the engine, by which all the pet cocks can be opened or closed at once. All parts of the winches are made on the duplicate-part system.

The steam stearing gear will also be supplied by the Lidgerwood Manufacturing Company, of New York, the engine being located at the after end of the engine casing on the upper deck level. One feature of the engine which is of importance is, that all the parts are made by gage, on the interchangeable-part plan, so that in case of breakage, wear or other need, new parts can be procured at almost instant notice, all fitted and ready to put in place. The worm wheel is of steel, with carefully cut teeth, and the worm is of bronze. The worm is in two parts for adjustment, to take up wear and prevent any backlash in the worm wheel, and a special feature is the use of roller-thrust collars at each end of the worm to save wear and give the greatest possible ease of operation. The cylinders are cast together as is customary, but this cast-

ing is separate from the bed and the bed and side frames are all cast separately, in accordance with the Lidgerwood custom, and fitted together with planed joints, held in place by turned bolts, which fit into reamed holes. The design is such as to allow for long connecting rods, and these are fitted with the regular Lidgerwood gib and key strap ends instead of the usual bolt and shim ends.

There is a Hyde windlass and a steam capstan located on the forecastle deck, with the windlass engine on the deck below, from which both are driven. Baldt stockless anchors are fitted. The vessel is heated throughout by steam.

The main propelling engine is triple expansion, with cylinders 22 inches, 37 inches and 60 inches diameter by 42-inch stroke. Piston valves are fitted to the high and intermediate cylinders and a double ported slide valve to the low pressure. Separate liners are fitted in the high-pressure cylinder and for the piston valves and a false face for the slide valve. All valves are operated by Stephenson double bar link motion. Steam reversing gear of the direct type is provided. The bed plate and housing are cast iron of box section. The crank shaft is built up in three interchangeable sections. A horseshoe type of thrust bearing is fitted. The propeller wheel is a solid cast iron one with four blades. The main air pump is of the Edwards patent type, driven from the low pressure crosshead. Two main feed pumps, two bilge pumps and an evaporator feed pump are also driven from the air-pump beam. The surface condenser is separate from the main engine framing and has a cylindrical cast iron shell with 1,900 square feet of cooling surface. A centrifugal pump, driven by a single vertical engine is used for circulating water through the condenser. All independent steam pumps are of the Blake type and consist of a ballast pump 10 inches by 10 inches by 12 inches duplex, donkey pump 9 inches by 5¼ inches by 10 inches vertical duplex, and donkey boiler feed 4½ by 2¾ by 4 inches special duplex. There is also a 12-ton Reilley evaporator.

There are two main boilers, each 15 feet diameter by 10 feet 10 inches long, built for 180 pounds working steam pressure. Each boiler has three 46-inch corrugated furnaces with separate combustion chambers, and 313 3-inch tubes. The total heating surface of both boilers is 4,400 square feet, and total grate surface 149.5 square feet. For supplying steam to the winches and for general harbor use there is a donkey boiler of the Scotch type located on the upper deck level above the main boilers. This boiler is 9 feet diameter by 10 feet 5½ inches long, and has one 52-inch corrugated furnace, 108 3-inch tubes and is built for a working pressure of 90 pounds per square inch.

THE SUCTION DREDGER LEVIATHAN.*

BY ANTHONY G. LYSTER AND W. BOYD.

The continual growth in the depth and size of steamers, which has culminated in the *Lusitania* and *Mauretania*, each drawing as much as 35 feet of water, has made it desirable to improve the existing depth of the bar channels of the Mersey, and, with this object in view, the Mersey Docks and Harbor Board in 1907 resolved, on the advice of their engineer, to construct a dredger of 10,000 tons capacity, and capable of dredging to a depth of 70 feet from water level to the bottom of the channel. This is necessary, having regard to the great range of tide at Liverpool, which amounts in the spring to as much as 31 feet. This dredger, known as the *Leviathan*, which has been built by Messrs. Cammell, Laird & Company, at their Tranmere Shipyard, is of the twin-screw, self-propelling hopper type, having a net hopper capacity of 180,000 cubic feet, and capable of filling herself with 10,000 tons of clean Mersey sand in fifty minutes from a maximum depth of 70 feet.

The principal dimensions are:

Length between perpendiculars......	465 feet 9 inches
Breadth, molded..................	69 feet
Depth	30 feet 7 inches

Under ordinary working conditions and in normal steaming trim, with the full load of 10,000 tons of sand in the hoppers, and with coal bunkers and water tanks full, the vessel is capable of traveling at the rate of 10 knots, the mean draft being 23 feet. The propelling machinery of the ordinary triple-expansion inverted marine type, with cylinders 22½ inches, 37 inches and 61 inches diameter, and 45-inch stroke, is by D. Rowan & Company, Glasgow, who also supplied the boilers, four in number, 16 feet diameter and 11 feet 9 inches long, working under a pressure of 180 pounds per square inch with natural draft.

The framing and plating are of steel throughout, and the scantlings generally have been arranged to meet the requirements for the 100 A1 Class in Lloyd's Register. There are eight complete athwartship watertight bulkheads extending to the upper deck, and five others, which are watertight, inside the hoppers only. There is also a center line watertight bulkhead, which extends from the fore end of the buoyancy space immediately in front of the hopper to the after end of the boiler room, thus dividing the hopper into twelve watertight compartments. The total number of watertight compartments in the ship is twenty-five, and they have been arranged with a view to complete safety should any two compartments become flooded. All the usual and necessary watertight doors and passages have, of course, been provided. The hopper itself is 162 feet long, and is 49 feet wide at the deck level; each of its twelve divisions has thus a section at its upper part of 27 feet fore and aft by 24 feet 6 inches athwartships. This rectangular section extends for a depth of about 20 feet, from which point the four walls of the compartment are sloped inwards, until they reach the bottom and terminate at the edge of the valve-discharge opening, which is circular and 5 feet 6 inches diameter. The side walls of the hopper, which are also watertight, form the inner walls of the side buoyancy spaces as shown.

The main idea of dredging and depositing the sand is simple enough; that is to say, sand and water are sucked up from the dredging level through long pipes by means of centrifugal pumps, and discharged by them into the hopper, where the sand settles to the bottom and the water is allowed to flow overboard from the top. The sand is finally discharged from the hopper in the desired locality by means of the discharge-valve openings in the bottom of each compartment. It is, however, in the detailed arrangement, by means of which this simple programme is carried out on an immense scale, that the interest lies.

The dredging machinery consists of four centrifugal pumps specially constructed by Gwynnes, Ltd., of London, for pumping sand, each pump being driven by a separate set of engines, and having a separate suction pipe fitted to the side of the vessel. This machinery is situated in the pump room immediately abaft the hoppers, the suction pipes being led where necessary through the side buoyancy spaces to the openings in the sides of the vessel. The engines are of the inverted triple-expansion surface-condensing marine type, with cylinders 15 inches, 25 inches, 40 inches by 18 inches stroke, working at 180 pounds pressure, and each set is directly coupled to its corresponding pump. Each of the four pumps has a suction and discharge aperture of 42 inches diameter, the suctions being of the double inlet type. The casings are of cast iron in halves, with portable centers on each side for the removal of the impellers, which are of cast steel and 6 inches wide at the

* From a paper read before the Institution of Naval Architects, April, 1909.

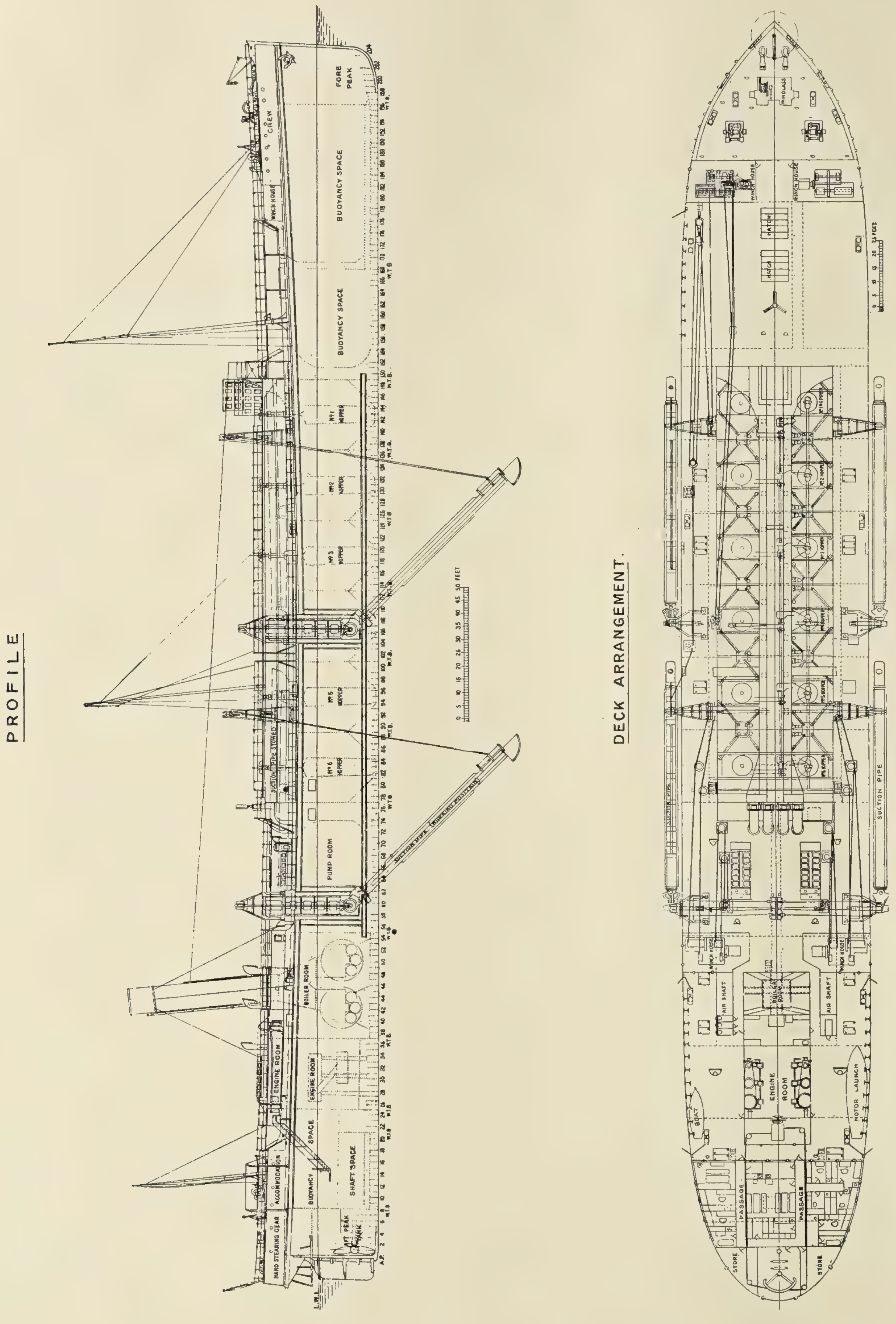


FIG. 1.—PROFILE AND DECK PLAN OF THE LEVIATHAN.

the tips of the blades. A sluice valve, operated hydraulically, is fitted between each suction and the ship's side, the lever and rods for working being brought within easy reach of the starting platform.

One of the most important points in the whole of the dredging system, and one which may be regarded as vital for the successful working of the dredger, is the design and arrangement of the suction tubes and their attachment outside of the vessel. They are four in number, two on each side of the vessel, situated as indicated on Fig. 1. It will be seen that the lead of each tube is forward, and they are of such a length as to enable dredging to be efficiently done in a maximum depth

As it was necessary to arrange for a lateral motion of the nozzle as well as a vertical one, the joint forming the attachment of the tube to the ship's side needed special and careful treatment in its design. It is formed by a cast steel swivel band, held up to a cast steel sliding flange by a ring of the same material, secured by steel studs and gunmetal nuts suitably locked. There is a heavy horn bracket with a brass bushed bearing for supporting the outer end and for lifting, and the swivel portion is of cast steel, with large bearing pins working on adjustable bearings. The upper bearing and bracket are removable for overhauling, and are fitted with recess and spigot to secure alinement. This bend acts as a

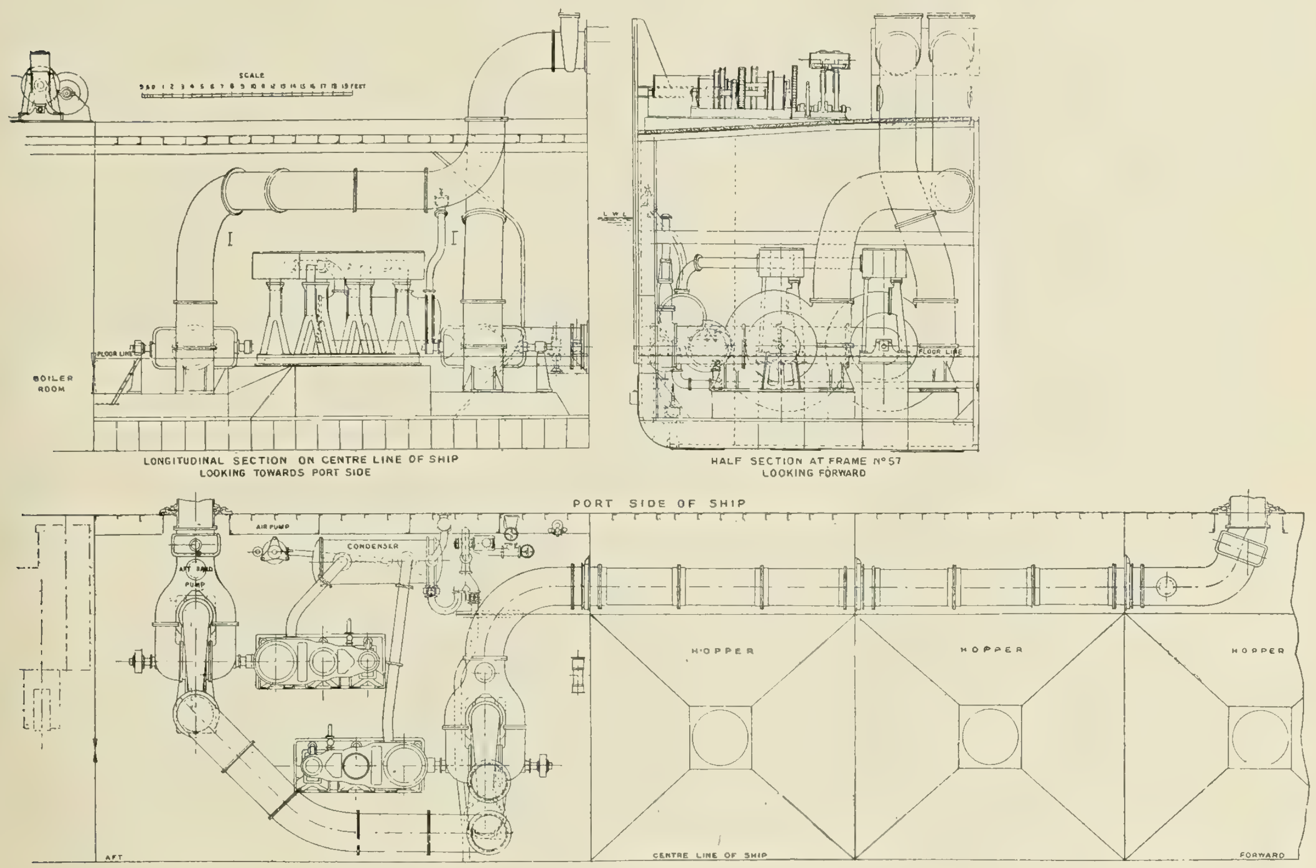


FIG. 2.—ARRANGEMENT OF MACHINERY IN PUMP ROOM.

of water of 70 feet, the depth being measured from the surface of the water to the surface of the sand; the angle of inclination of the tube does not exceed 45 degrees below the horizontal when dredging at the maximum depth. These tubes are made of wrought-steel boiler plates, the top half of the circumference being 8/20 inch thick, and the bottom 9/20 inch, with the circumferential joints quadruple riveted with single outside straps. Within each tube a midfeather plate is fitted for three-fourths of the length, extending at the sides between the angles connecting the upper and lower halves of the tube. An elm rubbing piece, fitted between large angles, runs along each side of the pipe, and a fender plate extends for a length of 30 feet on the rubbers, where chafing is likely to occur against the ship's lower side rubber. At each end of the tube, cast steel flanges are riveted for the purpose of connecting it to the swivel joint and nozzle. The nozzle itself consists of a cast steel flange and end grating, with a wrought steel body efficiently stayed. Elm rubbers are fitted on each side, and a manhole with cover is provided, while on the upper side of the tube near the nozzle there are suitable lifting brackets of forged steel.

trunnion or hinge, by which the tube is free to turn either about a vertical or horizontal axis, while the sliding flange works in a cast steel frame riveted to the ship's side, the guide bars being of wrought steel. By this means the tube can be raised bodily to the deck level and brought inboard, where provision is made for stowing it.

The raising and lowering of each tube is effected by two derricks, one at each end of the tube, both being worked from the same steam winch on deck. In connection with these jibs special cradles are provided to carry the frame supporting the swivel bend, with screw gear to move the cradle inboard or out as required. All the fittings in connection with the jibs are specially strong, and an emergency gear is provided for each tube, so that in case of a breakdown of the suspension rope or attachment to the suction head when the tube is below the water, the tube can be easily raised again. The gear consists of a spare length of wire rope, stowed, when not in use, along the outside of the tube. One end is attached to the suction head at the bottom and the other accessible from the deck when dredging is going on, a special sheave and lead to the winches being also provided on deck.

The four winches necessary for manipulating the tubes are each provided with four drums arranged in pairs, two for moving the derricks in and out, and two for raising and lowering the tubes, and are actuated by double-cylinder reversing steam engines. Each drum can be driven separately, and is capable of exerting a direct pull of 10 tons, and the machinery is so arranged that one man can control the whole of the movements required to be made by a suction tube; that is, adjustment in dredging position, hoisting and bringing inboard. These operations are directed by a "tubeman" at each tube, stationed at the ship's side directly over the place where the mouthpiece is located. This man constantly takes soundings by means of a line attached to the suction head, and also watches the vacuum obtained in the pumps, a very variable quantity, varying from 5 inches to 15 inches, which is indicated on a gage placed conveniently near. By these observations he is enabled to give the necessary directions to the winchmen for the manipulation of the tubes to keep the suction head up to its work with the maximum efficiency.

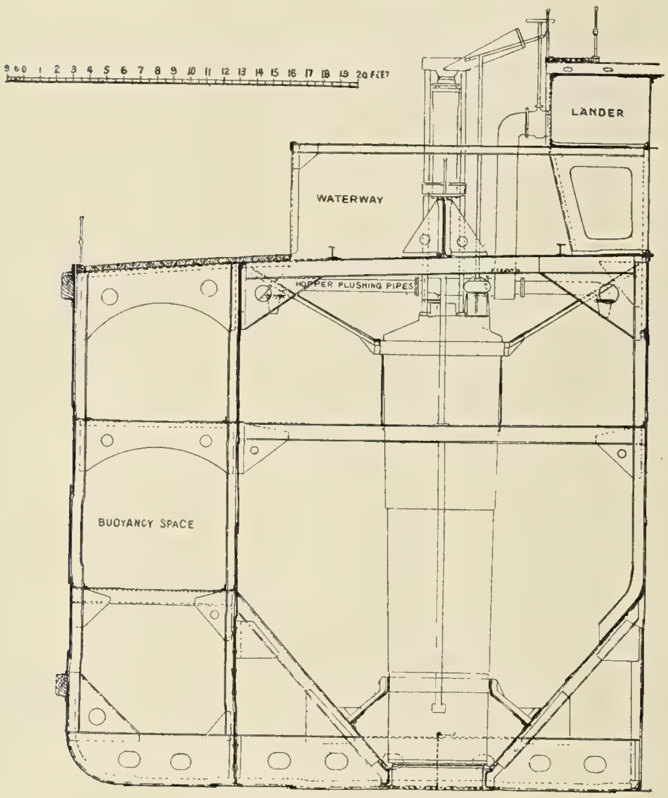


FIG. 3.—SECTION IN WAY OF HOPPER.

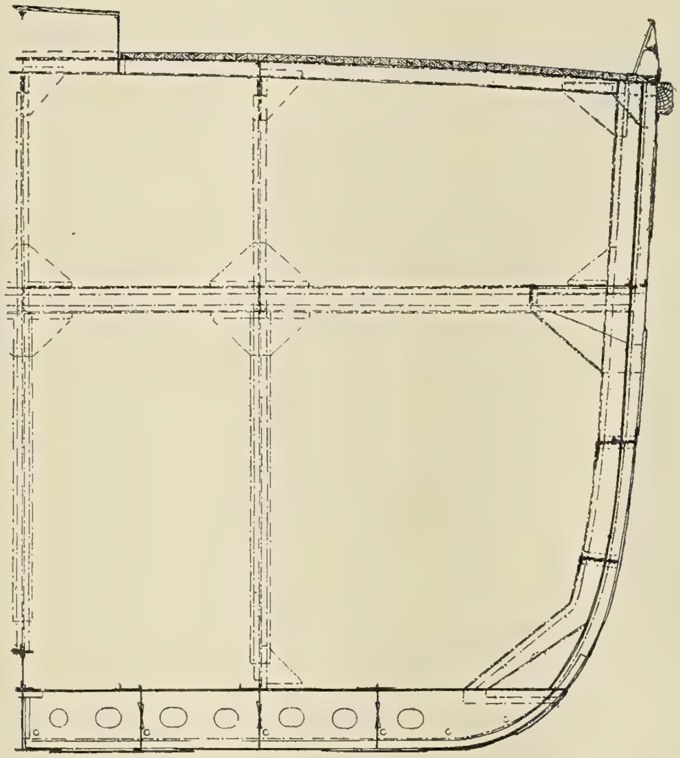


FIG. 4.—SECTION THROUGH FORWARD BUOYANCY SPACE.

The mixture of sand and water on leaving the pumps is discharged through two ducts or "landers" of rectangular section extending the full length of the hoppers. These landers run side by side, their common center wall being an upward extension of the center-line bulkhead; they are each 6 feet wide by 4 feet 3 inches deep, and are supported by brackets attached to strong thwartship beams. The bottom of each lander is covered with cement 2 inches thick, with a view to protecting the steel from the scouring action of the sand. The admission to the hoppers takes place through gate valves in the bottom of the landers; there are two to each compartment, with the exception of the end ones, and the openings are rectangular, 2 feet 6 inches by 11½ inches. At the extreme forward end the landers spread out in section to the full width of the hopper, in order to lessen the velocity and shock on the end bulkhead.

In order to obtain effectively a rapid settling of the sand in the hoppers it is essential that the velocity of the mixture should be reduced as nearly as possible to zero. Below the deck level in each of the twelve hoppers this takes place, naturally, while above this level a coaming, standing 7 feet above the deck, is provided all round the hoppers, forming a huge tank in which the large excess of surface water is brought virtually to rest. It is finally drained off over two weirs placed at the after end of the hoppers, escaping over side by means of four ducts, two on each side of the vessel. That this procedure is highly effective in separating water and sand may be seen by curves plotted to show the relative percentages of solid contained in the mixture while coming in through the landers and going out over the weirs during one loading of the vessel.

The process of discharging the sand from the hoppers, ordinarily known as "dumping," is carried out by means of Mr. A. G. Lyster's hydraulic valves, which have proved themselves so uniformly effective in other dredgers belonging to the Mersey Dock and Harbor Board. These valves are essentially large cylinders, extending from the valve opening (5 feet 6 inches diameter) in the bottom of each hopper to the deck level, and are operated by hydraulic rams, one to each valve, mounted on strong fore-and-aft girders, as shown in Fig. 3, the lift of each valve being 4 feet. In the crown of each hopper valve is fitted a special "surface-water" valve, worked by hand, the function of which is to drain off the surface water remaining on top of the sand and below the level of the weirs on the completion of the load; the interior of the hopper valves being, of course, open to the sea.

The hydraulic installation is necessarily of a powerful kind, and consists of one set of inverted high-pressure condensing engines and three single-acting main pumps, driven direct from piston rod cross-heads. The pump rams are 5 inches diameter, the stroke 15 inches, and the hydraulic pressure 800 pounds per square inch, working with a steam pressure of 100 pounds.

Owing to the tendency of the sand to consolidate and harden in the hoppers, a system of flushing pipes is arranged, as shown in Fig. 3. By means of these the sand can be loosened in discharging, and the hoppers effectively washed out. The

water for this system is supplied by the main pumps from the "landers," each lander having a closing door near the forward end of the hoppers, which permits the ordinary flow to the forward hopper to be stopped, and a pressure head created for the flushing system. The ordinary gate valves in the bottom of the landers are, of course, closed during the flushing operation. The efficiency of the means for getting rid of the sand may be judged from the fact that a load of 10,000 tons has been disposed of in the short space of ten minutes.

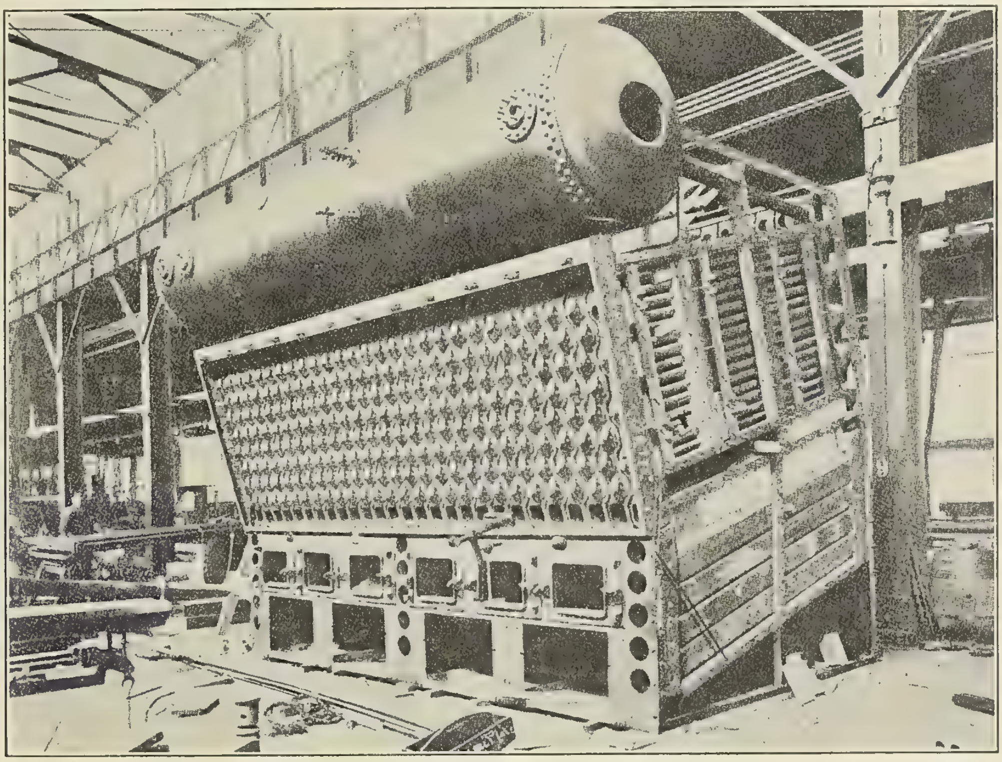
The vessel is lighted throughout by electricity, and the excellent accommodation provided for the working staff and crew is a feature which will conduce very largely to the working efficiency of the dredger. Ample spare gear is, of course, provided in view of the heavy and continuous nature of the work, and among other items might be mentioned the two spare suction tubes, complete and ready for mounting, which are kept in readiness.

The trials of the vessel gave very satisfactory results. The average speed on the measured mile was 10.48 knots, and the consumption of coal on a six hours' run was 1.3 pounds per indicated horsepower per hour, as against 1½ pounds, the contract limit. The boiler power proved very ample, so that the steam required was fully provided without any forcing. The sand pumping also gave very satisfactory results, although the material was not the "clean Mersey sand" to which the specification applies in the case of the trials, which requires the full load of 10,000 tons to be pumped in fifty minutes. On the occasion of the trials, pumping proceeded at a rapid rate until the pipes reached a stratum of material into which they would only penetrate very slowly, so that the rate of discharge fell off. Even under these disadvantageous circumstances the vessel loaded to within 7 percent of her full load in fifty minutes, and there is no doubt that in the specified material she will do the whole load in less than the time named. In the case of the Board's other dredgers the record loads have been done in the course of the ordinary work, so that a similar performance may be expected from the Leviathan in service.

NAVAL BOILERS IN SERVICE.

BY LIEUT. H. C. DINGER, U. S. N.

In the fleet that encircled the globe there were the following types of boilers: Double-ended Scotch boilers (working pressure 180 pounds) in the *Kearsarge* and *Kentucky*, single-ended Scotch (working pressure 180 pounds) in the *Wisconsin*, *Alabama* and *Illinois*, Thornycroft boilers (working pressure 230 pounds) in the *Missouri* and *Ohio*, Niclausse boilers (working pressure 265 pounds) in the *Georgia*, *Virginia* and *Maine*, Babcock & Wilcox boilers (working pressure 265 pounds) in the *Nebraska*, *New Jersey*, *Rhode Island*, *Louisiana*, *Connecticut*, *Vermont*, *Kansas* and *Minnesota*. The cruise has been in a large measure a good test of the lasting qualtities, reliability and adaptability of various types of boilers to conditions of extended cruising, and a review of the relative advantages developed, repairs now necessary and their general economy in coal consumption and repairs, is one of the valuable lessons that can be drawn from the steaming results and the general condition of boilers on their arrival on the Atlantic Coast.



ASSEMBLING A BABCOCK & WILCOX BOILER, SHOWING EASE WITH WHICH PARTS MAY BE REMOVED.

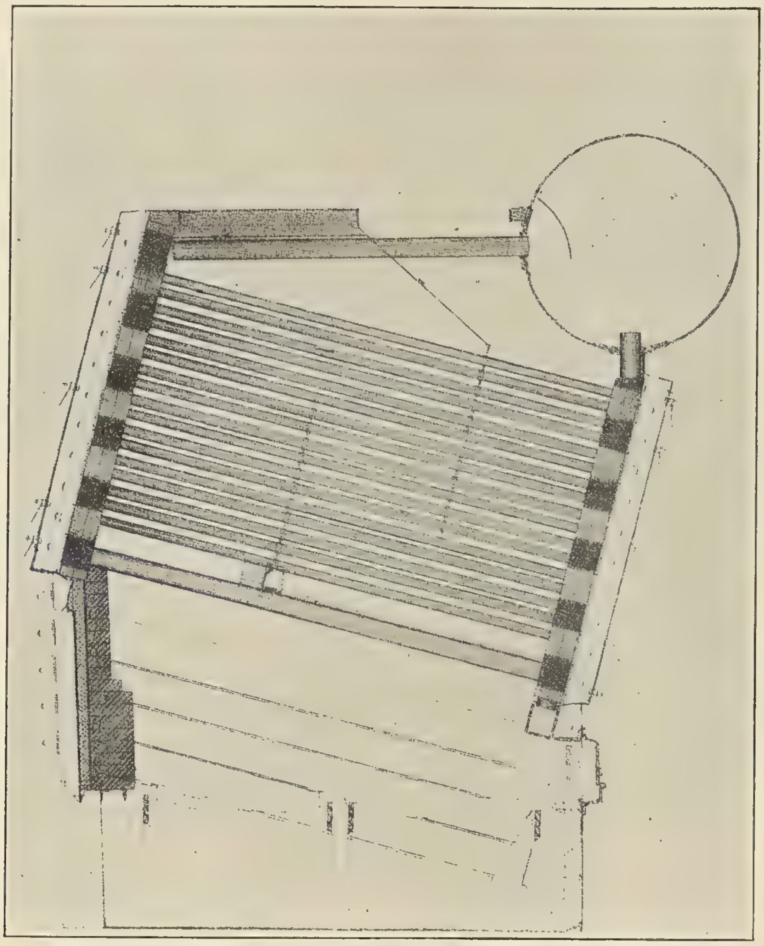
COMPARATIVE CONSUMPTION OF COAL.

Complete figures for coal consumption for the run home are not at hand at present, but the total consumption of the vessels while running in company from San Francisco to Manila was published some time ago. The results are as follows: The average consumption of the *Connecticut*, *Louisiana*, *Kansas*, *Vermont*, *Minnesota*, *Nebraska*, *Rhode Island* and *New Jersey* was 5,481 tons. The trial displacement of these vessels is 15,625 tons. The average consumption of the *Georgia* and *Virginia* was 5,873 tons. The average trial displacement of these vessels is 15,000 tons. The average coal consumption of the *Ohio* and *Missouri* was 5,600 tons, the trial displacement being 12,500 tons. The average consumption of the *Kearsarge*, *Kentucky*, *Illinois* and *Wisconsin* was 4,878 tons, the average trial displacement being 11,536 tons.

As the vessels differ in displacement, they should all be reduced to a common basis in proportion to the two-thirds power of their displacement. When this is done, the result is as follows:

	Tons.
Babcock & Wilcox vessels	5,481
Niclausse vessels	6,033
Thornycroft vessels	6,359
Scotch vessels	5,971

The saving of the Babcock & Wilcox boilers over the other types is thus: 552 tons over the Niclausse, 878 tons over the Thornycroft and 490 tons over the Scotch boilers. This is the result of only three months' service, steaming from San Francisco to Manila, viâ Australia. With this same proportionate saving carried on over several years it would soon cover the entire cost of boilers. This increase in economy, of course, means a corresponding increase in the steaming radius.



SIDE ELEVATION—BABCOCK & WILCOX BOILER, SHOWING BAFFLING.

GENERAL CONDITION AND OPERATION.

The Scotch boilers on the older vessels have been in constant service for eight or nine years, and are to a considerable extent worn out. These boilers now require a very considerable amount of repairs, and the question of reboilering these vessels with watertube boilers is now being considered. By reboilering with watertube boilers considerable weight can be saved.

The Thornycroft boilers on the *Missouri* and *Ohio* have worked very successfully. They have been in service six and five years respectively, but now require retubing, and their brick work and casing also need considerable attention.

The Niclausse boilers on the *Maine* have never operated with any commendable degree of satisfaction, and the troubles, begun very early in the vessel's career, apparently have never been successfully overcome. This vessel has been very uneconomical, both as regards coal consumption as well as in engineering repairs. It may be fair to say that this condition is not entirely due to the boilers, but undoubtedly the boilers can well be charged up with a considerable share of the bad repute. The Niclausse boilers on the *Virginia* and *Georgia* are of a later type than those of the *Maine,* and have, during the three and two and one-half years of their service, given better satisfaction. The *Virginia* has, however, required a considerable amount of repair work to her casings, and the *Georgia* is also in need of considerable repairs to the brick setting of her boilers. The casings of Niclausse boilers in other vessels, such as the *Pennsylvania* and *Colorado,* have also given a great deal of trouble.

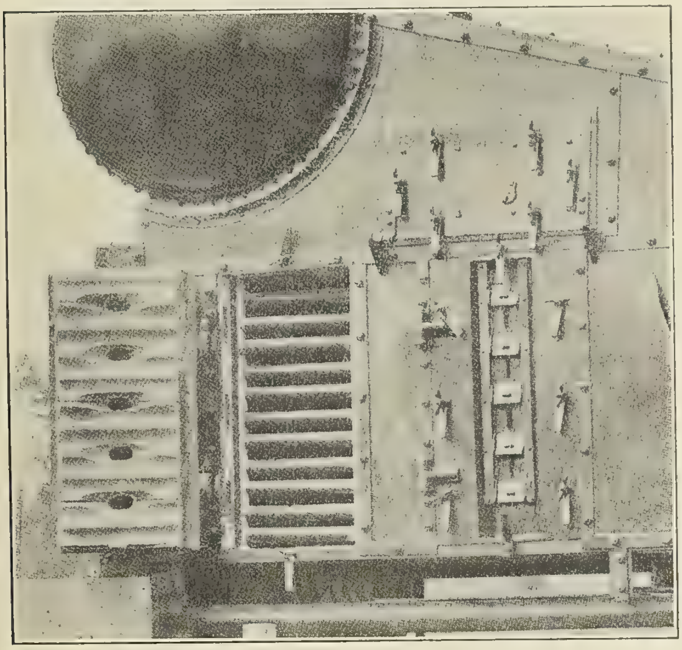
The Babcock & Wilcox boilers on the other eight vessels of the fleet have practically no repair work outside of the capacity of the ship's force; some of the boiler fittings, in common with those of the other vessels, require renewal and repairs.

Some of the principal causes for trouble are leaky bottom-blow valves. These valves have been the ordinary heavy bronze stop valves, and it has been difficult to keep these tight. A new valve of plug type, designed so as to prevent sediment cutting its seat, is being experimented with, and the use of valves with nickel seats and discs has also been suggested. In a number of cases some of the internal feed pipes have become detached, which defect is to be remedied by a new design of internal feed arrangement. Defective tubes have been discovered from time to time in all of the different types of boilers. To guard against this it is necessary to have the

very best material and to arrange the tubes so that corrosion and wear are reduced to a minimum.

The manner in which boilers are treated by the operating personnel and the hard or easy conditions under which they are caused to operate will, of course, have its full effect on the lasting condition of any boiler, and that boiler which can withstand most neglect and bad treatment without serious loss of efficiency has a most material advantage; for rough usage may of necessity be brought upon it on a naval vessel during war time.

Should defects in the tubes or pressure parts develop it is most important that they be easily remedied or repaired. The ability to make good a defective tube is, however, a point wherein the different types differ. In the Babcock & Wilcox boiler the ends of the defective tube may be plugged by simply lowering the water in the boiler, taking off the hand-hole plates at each end of the tube, inserting the plugs, refilling and starting up again. With the Niclausse boiler, the defective tube can be withdrawn and a spare one inserted, which would require about the same time as to plug a tube in the Babcock & Wilcox boiler, but while it is comparatively easy to locate a leaky tube in the Babcock & Wilcox boiler, it is a much more difficult matter to locate a small leak on a Niclausse boiler. On the Thorncroft or others of the express type it is also much more difficult to locate a small leak. And to do so it is necessary to cool the steam and water drums so that a man may get into each, and when the tube is located the plugging must be done from the interior of these drums. In the case of the Niclausse or Babcock & Wilcox boiler, the work of plugging or renewing of the tube is done by a man outside of the boiler. The Babcock & Wilcox boilers use an ordinary boiler tube which can be obtained at almost any large commercial center. The Niclausse boiler tubes are of special make, and for this reason cannot be as readily supplied in distant lands. To renew a tube in the Babcock & Wilcox boiler, each tube can be taken out separately by itself, no others being disturbed. In express boilers, except for a very few tubes, quite a number of good tubes may have to be cut out in order to get at the defective one. In some types of express boilers it is practically impossible to put in new tubes with the boilers in the vessel. In the express boilers, when a defective tube is discovered, it is usually plugged, and the process continued till there are so many plugged that the big job, often outside the capacity of the ship's force, of cutting out and replacing defective tubes is undertaken at a navy yard.



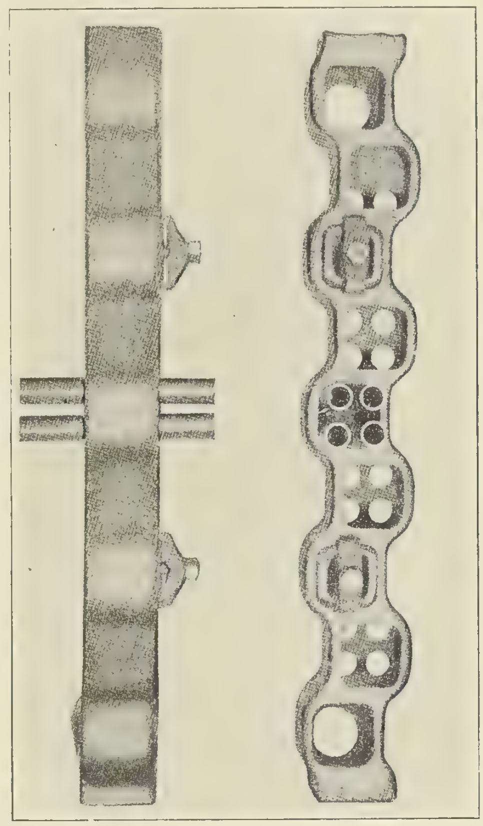
CLEANING DOORS—BABCOCK & WILCOX BOILER.

With the large tube boiler, arranged for independent examination and withdrawal of tubes, a defective tube can be renewed at once. Usually you never stop to plug a tube, as a new one can be put in in very little extra time, so these boilers can be kept in constant repair by the ship's force. This is of immense military advantage, and though the arrangements necessary cost something and also add weight, they are well worth the price, because you can have a boiler always ready for service and not one with a large percentage of the tubes plugged off.

It is possible to go thoroughly all over a boiler of this type, replacing any part desired, while at the same time having the boiler ready for steaming in a few hours in case it is required.

GREASE, SALT AND SEDIMENT IN TUBES.

These are conditions which many will say should not exist, but the fact is they do exist, and while it is sometimes possible to keep all three—grease, salt and sediment—out of the boiler, conditions do and will continue to arise where you will have them. This being so, the proposition then is how can they be gotten rid of and how can their presence be told before their ravages have become extensive? It is most important to be able to know the exact condition of the heating surface so that precautionary measures may be taken. Of course, a great deal can usually be done by use of soda or other cleansers and frequent blowing, but for thorough cleaning the heating surfaces should be capable of being looked at and accessible to cleaning by direct mechanical means. In the Niclausse boilers the field tubes do not drain, so these methods are not very effective, and the only effective way of getting the tubes clean is to remove the tubes and clean and replace them individually, a matter entailing a great deal of labor and also very careful work in replacement.



FORGED STEEL HEADER—HANDHOLE COVERING GROUP OF FOUR 2-INCH TUBES.

In the Babcock & Wilcox boilers each tube can be examined its full length and its surface thoroughly cleaned either with turbine cleaners, scrapers or brushes. In the express type of boiler this examination must be made from the interior of the drums, and if the tubes are bent the condition of their interior surfaces is never known. With the Babcock & Wilcox boiler any tube can be thoroughly examined inside of a few minutes. Thus any start at corrosion or wearing away can be detected and often remedied before it becomes a matter of importance.

PRIMING AND SCALE FORMATION.

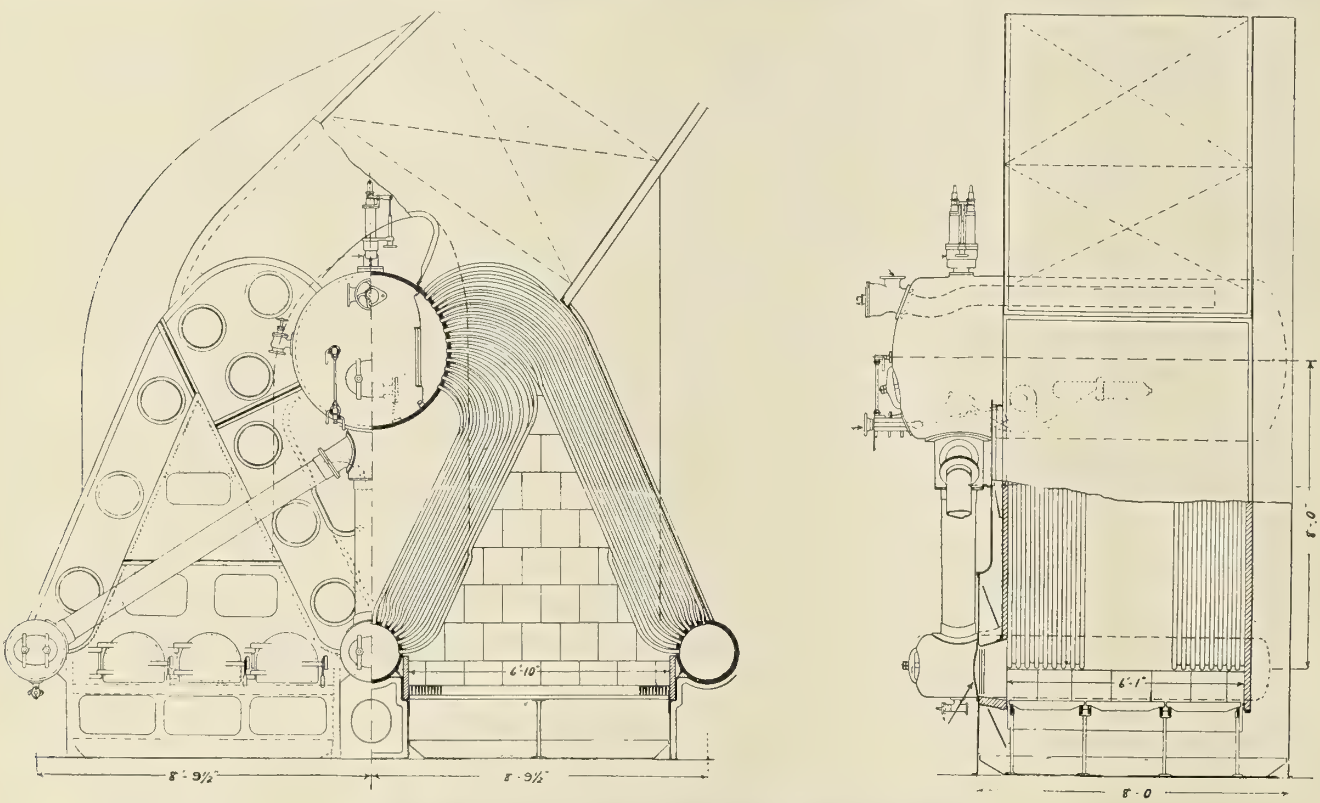
One of the things that it is most desirable to avoid is priming. Some boilers guard against this by the use of steam drums. Small tube or express boilers are peculiarly subject to priming when using salty or brackish water. Of course, boiler water is always kept as fresh as possible, but there are often unavoidable leaks in the condenser or other connections whereby salt water gets into the boiler. Sometimes there may not be time to repair the salt leak, and under these conditions a boiler that can be operated with salty water without priming has an advantage of considerable importance. One of the greatest drawbacks of the small tube or express boilers is the excessive priming when water that is at all salty is used. The recent trouble with the boilers of the *Salem* at Charleston is an extreme example of this.

Large tube boilers can be operated with salty water, and the Babcock & Wilcox boiler has repeatedly demonstrated its ability, on the around-the-world cruise, to operate without appreciable priming, even with a fairly high degree of saturation. Boilers employing the field tube do not operate successfully with salty water, and as sediment cannot be easily blown out, there is a much greater tendency to form scale. Thus the use of salt water in such boilers is attended with danger and difficulties.

In express boilers, when any scale has formed, there is much more danger of leaky or burnt-out tubes than in the Babcock & Wilcox or Scotch boilers, and when these troubles appear in small tube boilers the tube ends are not as easily accessible, and renewals are difficult to accomplish. Where small tubes are used, especially if bent, there is considerable danger in the scale deposit forming to such an extent in certain places as to cause the tube to be partially or entirely plugged. If scale should form in a boiler with straight tubes and accessible ends, the deposit can be thoroughly and easily cleaned out of the tubes, either by the use of scrapers or turbine cleaners. When scale or sediment of more than 1/16 inch thickness forms in small tubes (1½ inches diameter or less) it defies removal, either from straight or curved tubes, as no turbine cleaner of such small size can be made with parts sufficiently strong to stand up to the work.

COLLECTION OF SOOT ON HEATING SURFACES.

In continuous steaming all boilers gradually collect a considerable quantity of soot on their heating surface. This collection reduces both the capacity and economy of the boiler to a very great extent, and hence a most vital point in the design of a successful boiler is the ease, feasibility and thoroughness with which this collection of soot may be removed while the boiler is steaming.



THORNYCROFT BOILER, AS INSTALLED ON UNITED STATES BATTLESHIPS.

The ability to remove soot from the heating surface, while steaming, is one of the cardinal advantages of the Babcock & Wilcox boiler. By means of a steam or air lance, operated through the dusting doors provided in the sides of the casing, the soot is dislodged, and either carried up the smoke-pipe by the draft or it drops down and lodges on the horizontal baffle laid over the row of 4-inch tubes immediately above the fire. By means of a door in the casing, this horizontal baffle can be thoroughly cleaned of the soot. So the boiler can be cleaned at any time and kept clean while steaming. In other types of boilers the means for cleaning tubes of soot while under steam are defective, and in no types yet put into use have the facilities for thoroughly cleaning the fire-sides of soot approached in any respect those provided with the latest type of Babcock & Wilcox boiler. This advantage looms up particularly when steaming long distances at high power. Though

many boilers show good results when starting out clean, as soon as the soot deposit becomes considerable the economy and free steaming of the boiler disappear or drop very materially.

ARRANGEMENTS FOR BAFFLING GASES.

The economy of a boiler depends to a considerable extent upon the arrangements provided for baffling the gases of combustion and conducting them along the heating surface so that it will be most effective. The arrangement of the Babcock & Wilcox boilers allows for three passes across the nest of tubes. This brings about a rapid flow of gases past the heating surface at right angles to the length of the tubes and also keeps the gases in contact sufficiently long to enable practically all the available heat to be extracted, without a large ratio of heating to grate surface. The up-take temperature on Babcock & Wilcox boilers is remarkably low, and with good firing the temperature at the end of the last pass seldom exceeds 500 degrees F., even with as much as 2 inches air pressure.

The Niclausse boilers are not as well baffled. Their uptake temperatures are higher, and there is consequently a much greater loss of heat passing up the smoke-pipe. Considerable difficulty is experienced in Niclausse boilers in securing bafflling in place, and burning out the baffling tubes is a constant source of trouble.

Most types of express boilers are not well baffled to secure good economy and low up-take temperature. Owing to structural features in most types of express boilers satisfactory baffling cannot be fitted; frequent attempts at baffling these boilers have resulted in forming pockets from which it is practically impossible to remove soot and ashes.

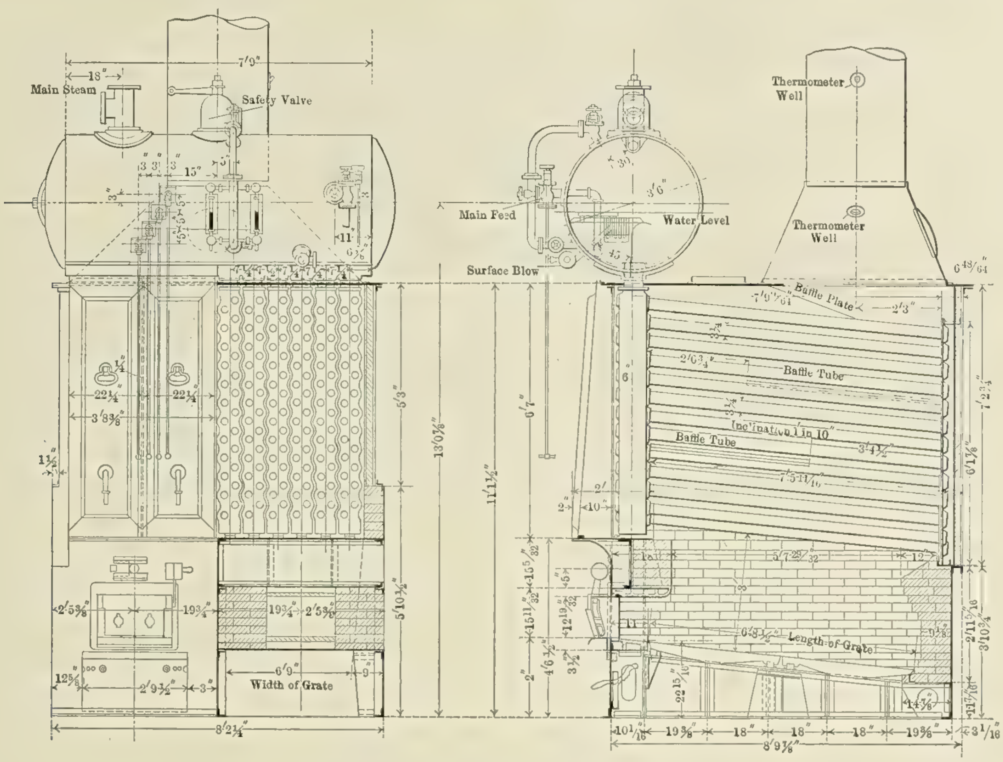
DURABILITY AND ACCESSIBILITY OF BOILER CASING.

Another important feature from an operating point of view is the durability of the boiler casing and the ease with which damaged parts may be replaced. The sides and backs of the Niclausse boilers are built up largely of brickwork, and in service this brickwork, due no doubt largely to the movement of the vessel, shock of firing guns, etc., cracks and deteriorates, so that considerable repairs are frequently necessary. Distortion of the casing, due to overheating, has also been experienced. The upkeep of the casings and brickwork of Niclausse boilers thus far used in service has been a matter of considerable expense.

Express boilers also require a considerable quantity of brickwork, which in many places requires frequent and continued renewal, also due to the positions of the lower drums; a considerable portion of the casing is in a position where conditions tend to corrosion and where examination and repairs are very difficult and in many cases impossible.

The durability and the ease with which any part of the casing of the Babcock & Wilcox boiler used in the United States navy can be replaced by unskilled labor has been well demonstrated in the fact that there have been practically no repairs necesary to the casing of any of the later type of this boiler, though there are many hundred thousands of horsepower in service, and many have been in continuous service six years. With this boiler there are no easily damaged parts of the casing near the bilges, hence there is no corrosion to the casing. The casing is made in removable sections, and no part of the casing or boiler front supports any part of the pressure parts. The boiler can be completely stripped, with all the pressure parts and piping connections in place, and this can be done without cutting any rivets, and the casing can be replaced without the need of any new material except such as may have given away, but none of the parts have to be broken or damaged in any way in order to take the casing off. Furthermore, any defect in the casing can be easily seen, so that it can be made good before it is extensive. The accessibility of all parts of the boiler is such that any one can be removed with but very slight or no disturbance of any other part, and such removal can be accomplished by the ordinary fire-room force. Thus a side-box, a mud-drum or a header can be taken out and replaced, the side-box in a few hours, the header or mud-drum in a couple of days, by the ship's own force and without any but ordinary boiler makers' tools.

The only seams on a Babcock & Wilcox boiler are on the steam drum; they have never been known to leak, and if by chance they should, the leak is readily seen and can easily be



NICLAUSSE BOILER, AS INSTALLED ON U. S. GEORGIA.

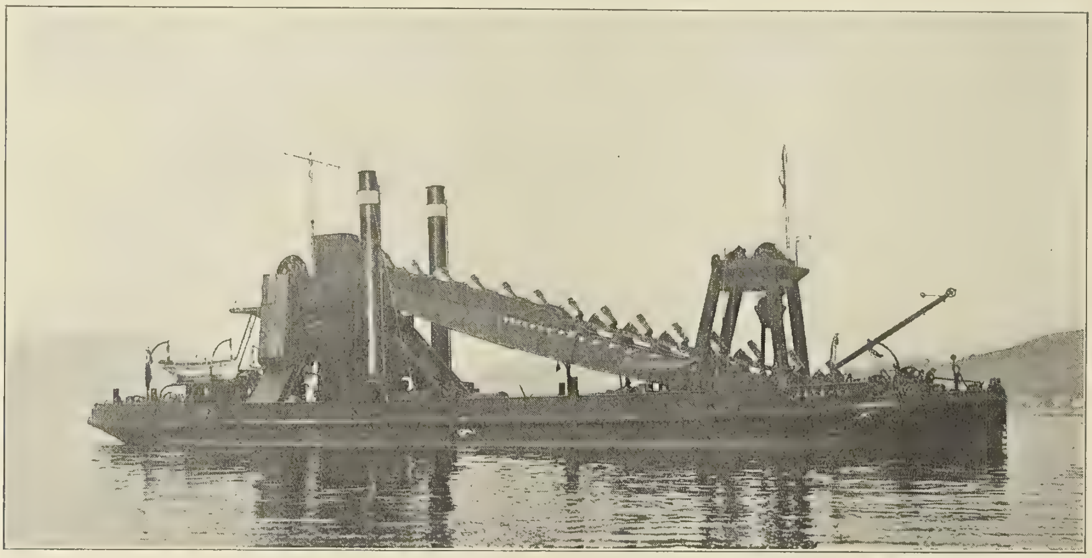
calked. In the case of express boilers, seams have often to be placed where it is difficult to calk them. Retubing or removal of a considerable number of tubes means an almost complete dismantling of the casing and usually the renewal of many parts that are damaged in the process of removal.

SAVING OF WEIGHT BY USING EXPRESS BOILERS.

The weight saved in express boilers has to be paid for, and it is paid for, as has been shown, in the excessive cost of repairs to these boilers and the difficulty encountered in renewals of various parts. (2) In the lack of economy in continuous, long steaming, due principally to lack of good baffling and the collection of soot, which cannot be effectively removed while the boiler is in use. (3) In the difficulties experienced when such boilers are called upon to use anything but thoroughly fresh and clean water, and the danger of leaks and tube failure where even slight deposits of salt are met with. (4) In the inability to make good slight defects as they are noticed, so that the boilers cannot be always in the best shape with the vessel in active service.

These conditions would bring out the question of whether the increased advantages in boilers of the Babcock & Wilcox type are really worth the increased weight and cost over express boilers. On a battleship the boiler weights are about $2\frac{1}{2}$ percent of the total weight of the ship. By using some type of express boilers this weight might be reduced about three-fourths of 1 percent of the total weight of the vessel. On the score of weight saving it seems that this small extra weight, about 100 to 150 tons in our largest battleships, is well applied when the superior advantages are considered. As to first cost, some express boilers capable of doing the same work may be installed for about 20 percent less, but this difference is easily made up in one or two years' repair bills, or a couple of years' increased economy of coal consumption, to say nothing of the increased military efficiency of being always ready for service.

The adoption of a light express boiler, or one of a less reliable, economical or durable type than the one which has thoroughly demonstrated its advantages would seem to be a decidedly backward step, and one that sacrifices military efficiency and preparedness to temporary expediency. It may be urged that foreign navies have, to a considerable extent, used express boilers on their battleships, and that, therefore, this move should be followed, but in answer to this it may be stated that the German navy, or at least its battleships, do little extended cruising, and they never have had in their navy a boiler that approaches the complete answer to practical naval requirements of that developed in our service, and though the British navy does use large, straight-tube express boilers on some of its battleships, the larger portion of its recent installations consists of the English type of Babcock & Wilcox. Good express boilers have their field in torpedo craft and fast scout vessels, where economy, durability and reliability have to be sacrificed in order to get the weight for the necessary power. In large vessels of the fighting line, where the boiler weights are only about 2 percent of the total weight, this sacrifice is not necessary, and any step tending toward it would appear most unwise.



BUCKET DREDGER FLEETWOOD.

THE BUCKET DREDGER FLEETWOOD.

This vessel is the largest and most powerful bucket dredger owned by the Lancashire & Yorkshire and London & North-Western Joint Railway Companies. She is of the bow-well, center-bucket ladder type; length, 172 feet; breadth, 36 feet 6 inches; depth, 12 feet molded, and she is capable of raising 900 tons per hour. The vessel is built to Lloyd's highest class. The bucket ladder and box framings for supporting the chain of buckets and dredging gear have been constructed of the best class of girder work, all put together and efficiently connected with steel rivets closed by hydraulic pressure.

Side shoots are arranged for discharging the dredged material over either side of the vessel into hopper barges, the lifting and lowering of each shoot being worked by an independent engine. The regulation of the spoil to either side of the vessel is controlled by a strong, flat valve door, fixed at the apex of the shoots and worked by a gear from the main deck.

Separate accommodation is provided under the deck for the captain, engineers, crew and laddermen. The living quarters are well fitted up and well lighted and ventilated.

Steering gear is fitted on the bridge, which is placed on the highest point of the dredger at the top of the main gear framing. A complete installation of electric light is fitted throughout.

Heavy elm beltings are fitted all round the vessel, also strong, vertical fenders at intervals, to take the wear of the barges lying alongside.

The bucket ladder is suspended independently of the upper tumbler shaft. The main engines, which are employed for either propelling the vessel or driving the dredging gear, consist of one set of the triple-expansion, surface-condensing,

inverted direct-acting type, having three cranks, and capable of developing 700 indicated horsepower. Steam reversing gear is fitted, also auxiliaries embodying all the latest improvements. Steam is supplied from two cylindrical return multitubular boilers, constructed under Lloyd's special survey.

The dredging machinery is of massive design. The gearing is arranged to work the buckets at two different speeds, according to the nature of material being dredged. All wheels, pinions, clutches, tumblers and bucket backs are of cast steel. The upper tumbler shaft is driven by a friction spur wheel of large diameter and capable of being adjusted to convey the necessary power to the buckets, according to the hardness of material being worked. The hoisting gear for the bucket ladder consists of a heavy wire-rope tackle, working in upper and lower sheave blocks suspended from a cross-head fixed on a box-framing structure built into the hull at the forward end of the vessel, the lower sheave blocks are connected to the bucket ladder by strong forged side rods, the wire rope is wound on a large, grooved barrel, driven by gearing from a double-cylinder engine, all placed under deck. The wheels and handles for working this gear are placed on deck, under the control of the dredging master. The dredging buckets and links are of a specially strong design, each bucket having a capacity of 21 cubic feet; the connecting pins for the bucket chain are of manganese steel. A large crane is fitted on deck for overhauling buckets and links and for general purposes.

Six powerful steam winches are fitted, three at the bow and three at the stern of the vessel, for manipulating the mooring chains and holding the dredger up to its work. Each winch is driven by a two-cylinder engine. The dredger is capable of a speed of 7 knots. She has a very complete outfit of stores and spare gear. The builders were Ferguson Bros., Port-Glasgow.

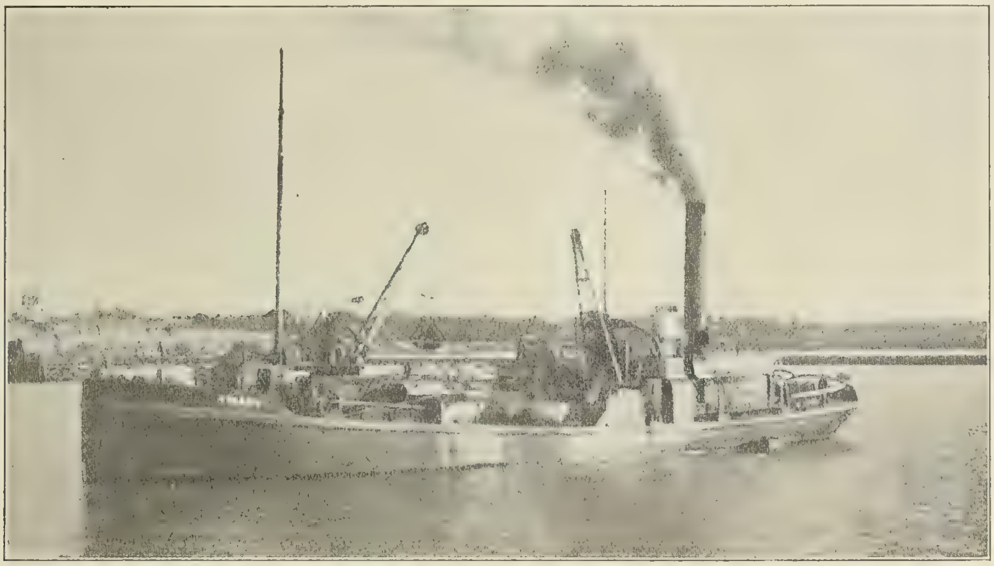


FIG. 1.—A STEAM HOPPER BARGE, FITTED WITH TWO KINGSTON DREDGING MACHINES.

KINGSTON DREDGING MACHINES.

The Kingston dredging apparatus, manufactured by Messrs. Rose, Downs & Thompson, Ltd., Hull and London, is a self-contained piece of machinery which can be mounted on a barge or float or on a self-propelled hopper barge for dredging operations to be carried out at a great depth below the water level or in inaccessible places around quays and docks.

Fig. 3 shows the apparatus complete with boiler installed on an ordinary wooden barge not hoppered, while Fig. 2 shows the apparatus installed on a small self-propelling hopper barge. In this case steam for the dredging machinery is supplied by the main boiler of the barge. This class of machine is designed to convey its own spoil, and the particular one illustrated is capable of carrying 125 tons of spoil at a speed of 6 knots. Two or more machines can be mounted on one hopper, as shown in Fig. 1, thus making a very compact harbor-dredging plant, capable of giving a daily output up to 4,000 tons.

The steam hopper barge shown in Fig. 1 has separate propelling engines and boiler, and two Kingston dredging machines fixed fore and aft of the hopper well. A complete

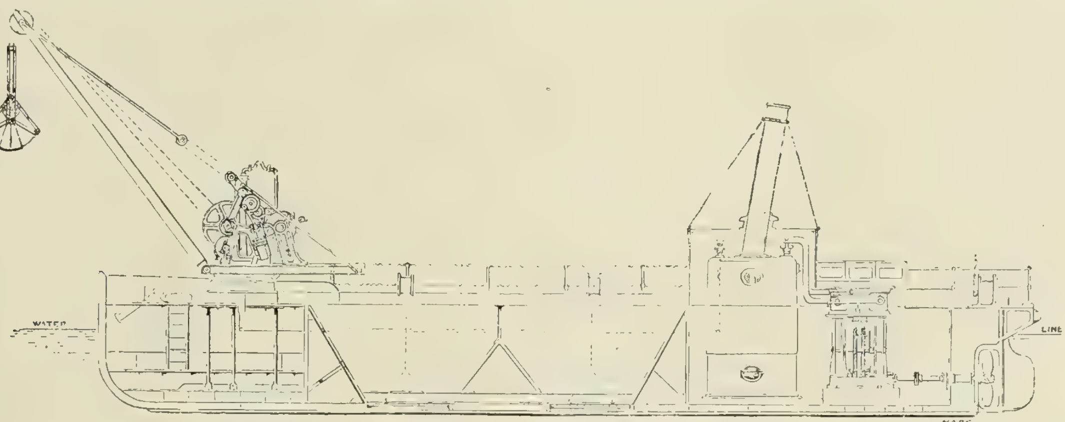


FIG. 2.—KINGSTON DREDGING APPARATUS ON A SMALL SELF-PROPELLED HOPPER BARGE.

plant of this description can be supplied capable of a daily output from 2,000 to 5,000 tons.

In the construction of the Kingston dredgers no sliding counterweights are used to check the descent of the grab bucket. In ordinary types of similar machines the bucket is supported by two chains—the closing or hoisting chain, and the opening chain, the opening chain being held in tension while the bucket is lowered, and is capable of being stopped to allow the dredgings to be discharged, which is done by allowing the entire weight of the bucket to come upon the

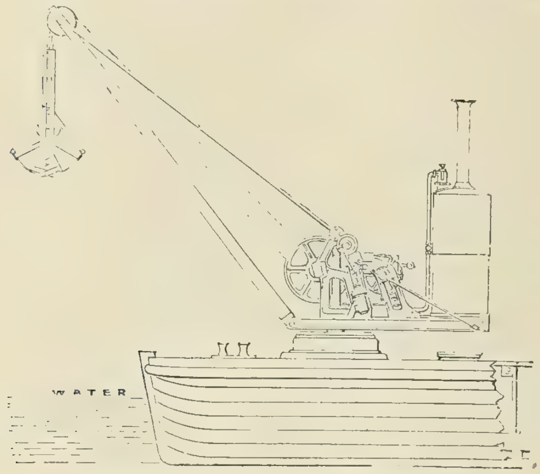


FIG. 3.—SELF-CONTAINED APPARATUS.

opening chain. This chain is usually connected by a series of sheaves to a weight moving against a vertical slide beside the boiler. As the grab is lowered this weight is raised, thus keeping the grab open by the tension on the chain. In the Kingston dredgers the opening chain is led to an auxiliary winch, so that when the grab is allowed to run out there is no counterweight tending to stop it, and the full energy of the falling bucket is employed in embedding itself in the material to be lifted.

The Lord Desborough.

The largest dredger that has been built on the Clyde, and also one of the largest dredging vessels afloat, is the *Lord Desborough,* 330 feet long, 54 feet 6 inches beam and 23 feet draft. She is fitted with double suction pipes, arranged to ship inboard, and is capable of raising 4,500 tons of sand per hour from a depth of 70 feet below the water level. The navigating and pipe-maneuvering bridges are placed forward of the hopper, while the chart room and steering house are on the upper and lower bridges, respectively. An accommodation gangway leads from the lower bridge to the engine casing, and on this gangway the gearing for working the lander doors, wash-out valves and hopper valves is arranged. Officers' accommodations are arranged aft of the machinery space, including a special suite of rooms for the superintending engineer. The crew's quarters are forward of the hopper.

The propelling and pumping engines, which were constructed by the builders, are of the triple-expansion type, using steam at a working pressure of 180 pounds per square inch. Steam is supplied by three multi-tubular boilers, each 15 feet in diameter.

The vessel has the following auxiliaries: Three sets of Weir's pumps, one Weir's evaporator and feed heater, four Gwynne's centrifugal pumps, a Kirkcaldy's distiller and pump, also a separate duplex for water supply to the sand pumps. Electric light is fitted throughout. The telegraphs are by Messrs. Chadburn, and consist of seven transmitters and six indicators. The pipe-maneuvering winches are of massive design, each having four barrels and weighing about 20 tons.

The vessel was constructed by Ferguson Bros., Port-Glasgow, under the direction of A. G. Lyster, of Liverpool, assisted by Messrs. H. West & Sons, Liverpool.

CURTIS TURBINES FOR THE NORTH DAKOTA.

Fig. 4 is a vertical section of one of the Curtis turbines now being built by the Fore River Shipbuilding Company, Quincy, Mass., for installation in the battleship *North Dakota.* The *North Dakota* is designed for a normal displacement of 20,000 tons, and requires for a speed of 21 knots approximately 25,000 horsepower. This is to be supplied by two Curtis marine reversible turbines, each of about 12,500 horsepower, driving twin screws. The turbines are to be operated at 245 revolutions per minute at full speed, with a steam pressure of

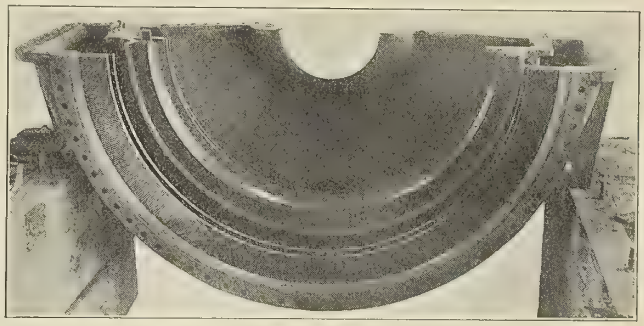


FIG. 1.—LOWER PORTION OF EXHAUST END CASING.

265 pounds per square inch in the steam chest and 28 inches vacuum in the exhaust shell. Each turbine is 144 inches pitch diameter and 22 feet 6 inches long center to center of the main bearings. The expansion of the steam is divided into nine stages in the ahead turbines and two stages in the reverse turbines.

The turbine consists of a cast iron cylindrical casing, divided by dished cast iron diaphragms into the requisite number of compartments or stages. In each compartment, or stage, except the first and the last four, there is a separate wheel, which carries on its periphery three rows of moving buckets. In the first stage there are four rows of moving buckets on the wheel, since the greater energy drop in this stage produces a greater velocity of the steam jet from the nozzles, which requires more rows of buckets to properly absorb the energy at the bucket

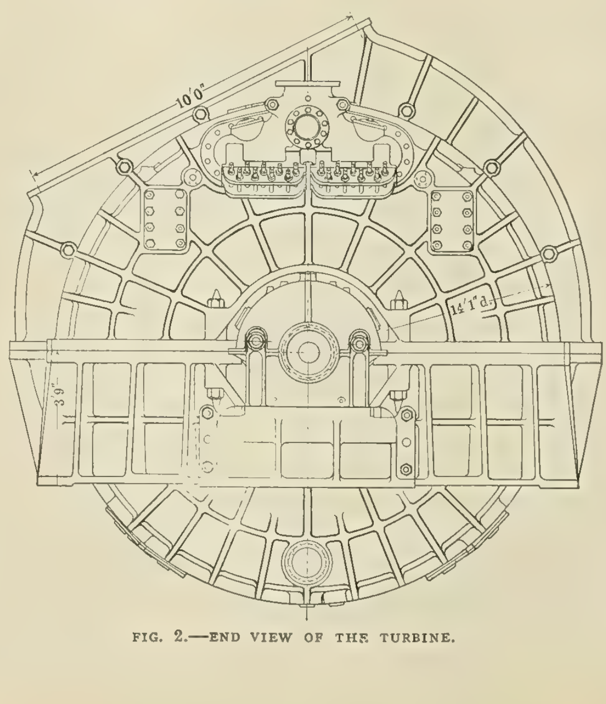


FIG. 2.—END VIEW OF THE TURBINE.

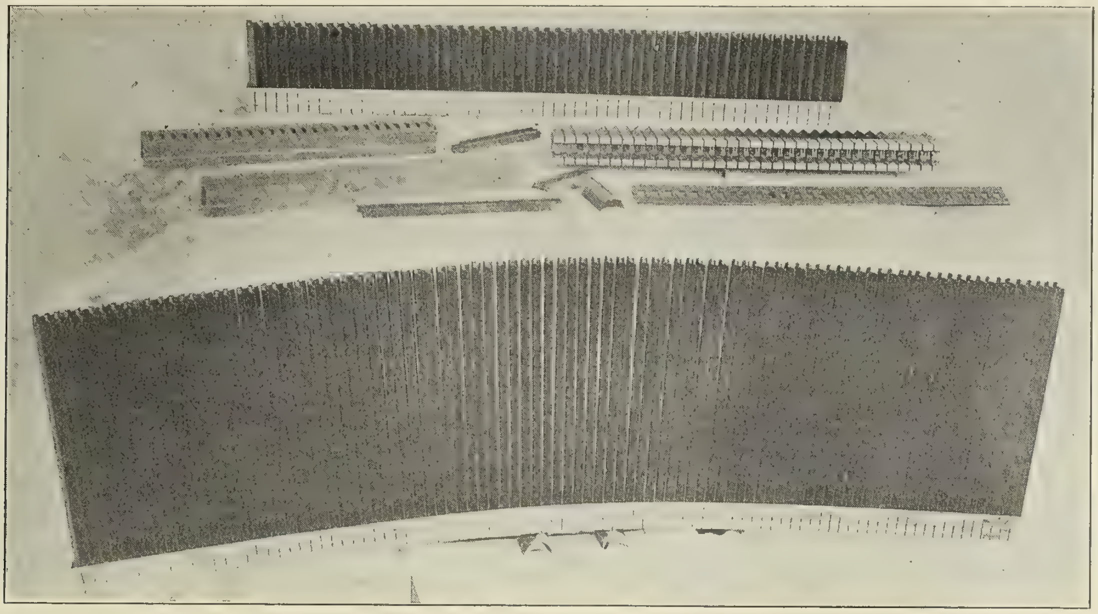


FIG. 3.—DETAILS OF BLADING.

speed used. One-fourth of the available energy of the steam is expended in the first stage and thirty-three seconds in each of the other stages. This is done in order to keep the pressure in the shell as low as possible. It requires, however, that the first-stage nozzle shall be of the expanding type, while all the other nozzles are of the parallel-flow type. The moving buckets for the sixth, seventh, eighth and ninth stages are all mounted on a single drum, there being three rows of buckets to each stage. The wheels and drum are all mounted on a hollow steel shaft, carried by self-alining bearings at either end of the turbine casing. Where the shaft passes through the diaphragms which divide the turbine into stages they are provided with bronze bushings having a small clearance, thus preventing appreciable steam leakage from one stage to the other. Where the shaft passes out through the ends of the casing it is provided with carbon stuffing-boxes, which prevent steam leaking out at the head end or air leaking in at the back end where a vacuum exists. The stuffing-boxes are supplied with steam in the space between the carbon packing, to prevent air leakage.

The reverse wheels are mounted in the after end of the casing, and under ordinary conditions, when the turbine is running ahead, they are in a vacuum, and, therefore, do not waste power by steam friction. Cast steel steam chests for

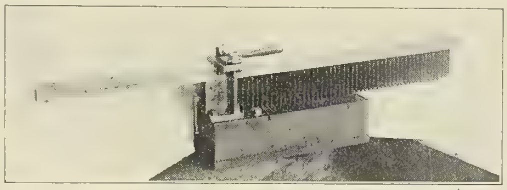


FIG. 5.—RIVETING JACK.

ahead and astern running are attached to the front and back casing heads, as shown, and are flanged for main steam pipes 13½ inches in diameter. The exhaust is through a rectangular opening 4 feet by 10 feet in the top of the casing at one side of the center line.

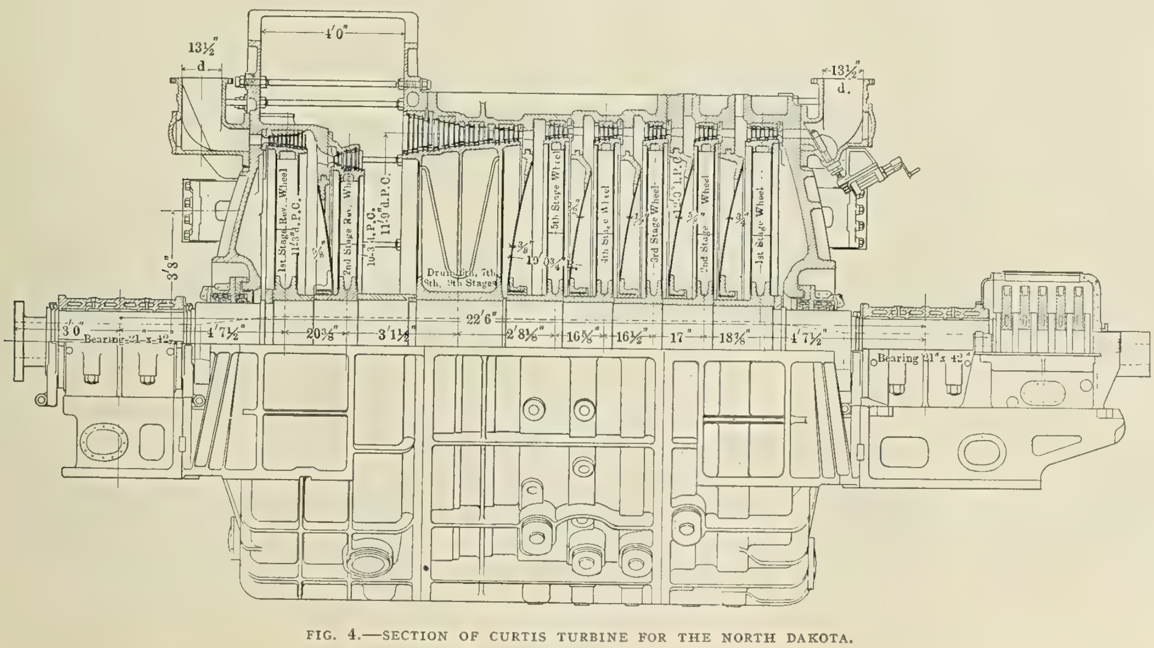


FIG. 4.—SECTION OF CURTIS TURBINE FOR THE NORTH DAKOTA.

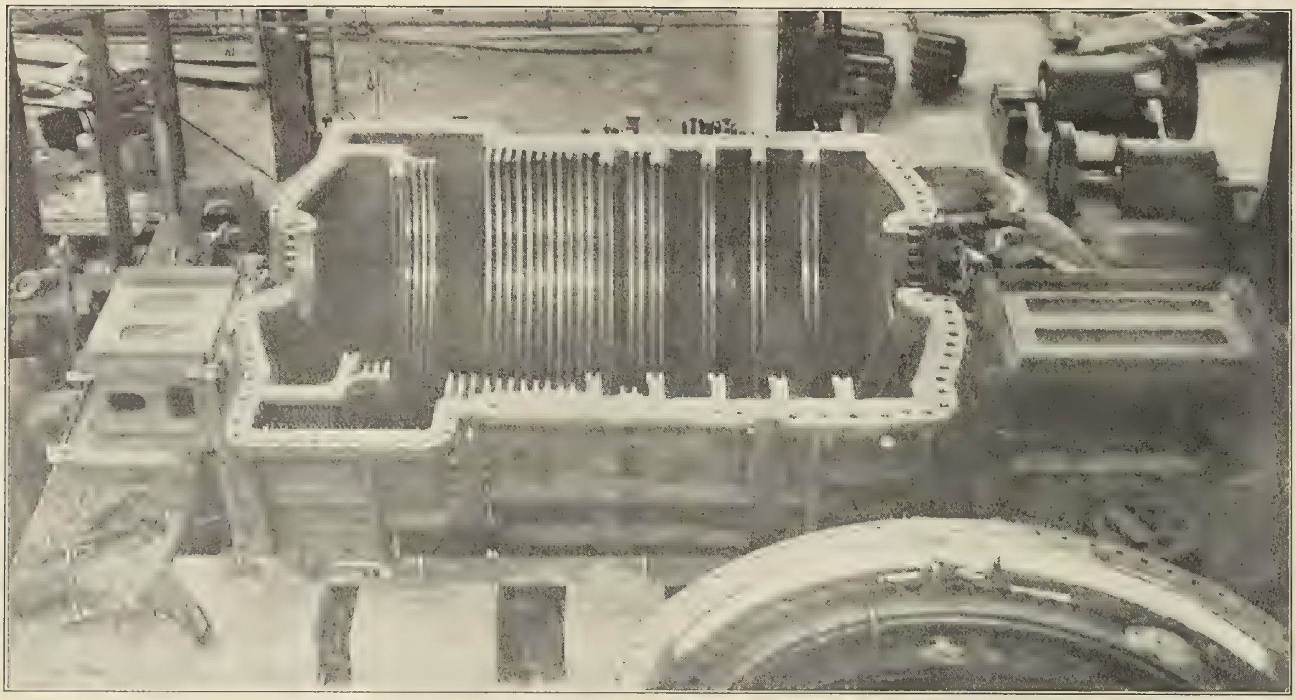


FIG. 6.—INTERIOR OF CASING.

A regular marine thrust bearing is attached to the forward end of the turbine shaft, the thrust block forming an extension of the forward main bearing. In addition to taking any unbalanced thrust which may occur, this bearing also maintains the proper axial position of the rotor, so that the axial clearance of the blades is correct. This clearance is about 1/10 inch on the first wheel, and increases as the size of the blades increases. The thrust bearing is placed at the forward end so that any unequal expansion of the shaft and casing will be allowed for at the after end, where the clearance is largest. The axial clearance is ample to allow for all unequal heat expansion that may occur and any mechanical irregularities, and leaves sufficient leeway for adjustments. Small clearances, both axial and radial, are unnecessary in the Curtis turbine, since the steam pressure on both sides of the wheels in each stage or compartment is uniform. Therefore, there is no tendency for leakage around the blades, and the clearance can be made as large as desired for proper mechanical construction. The only limit to the axial clearance or the distance between the edges of the blades is the

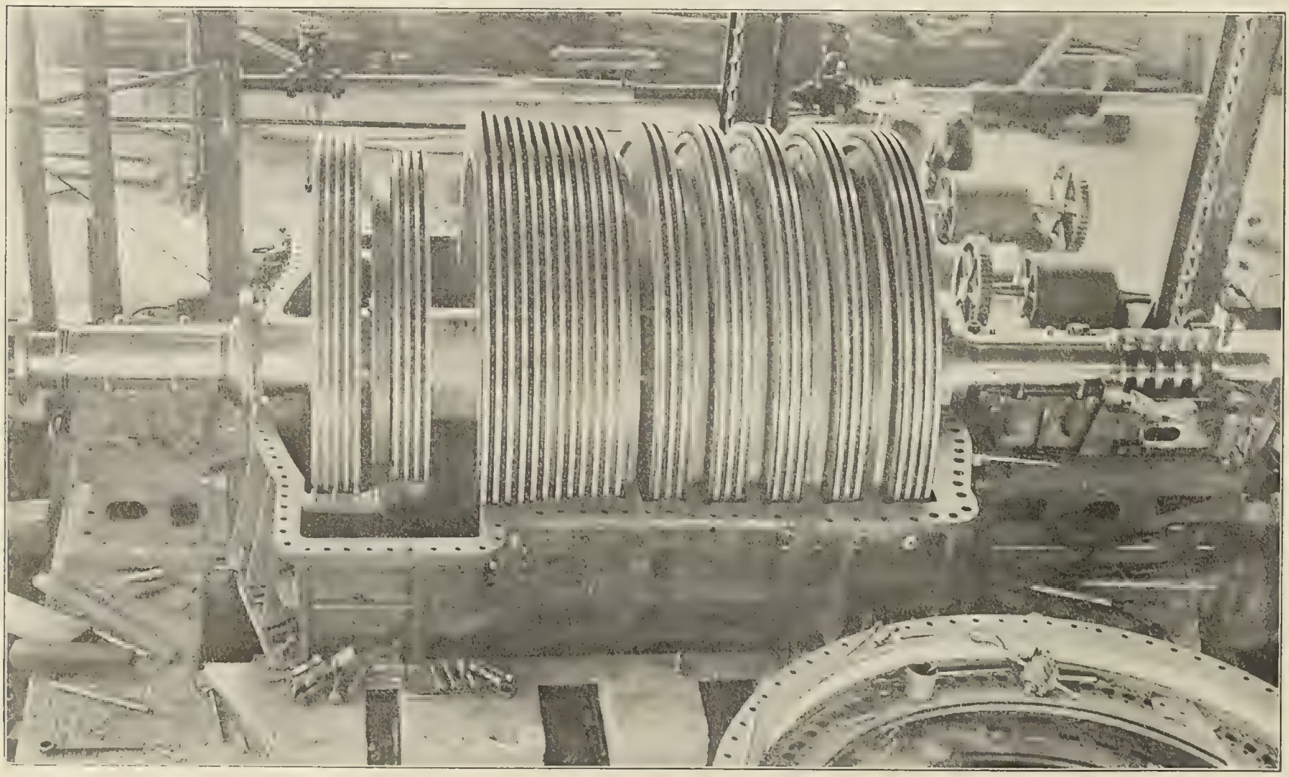


FIG. 7.—ROTOR IN PLACE IN CASING.

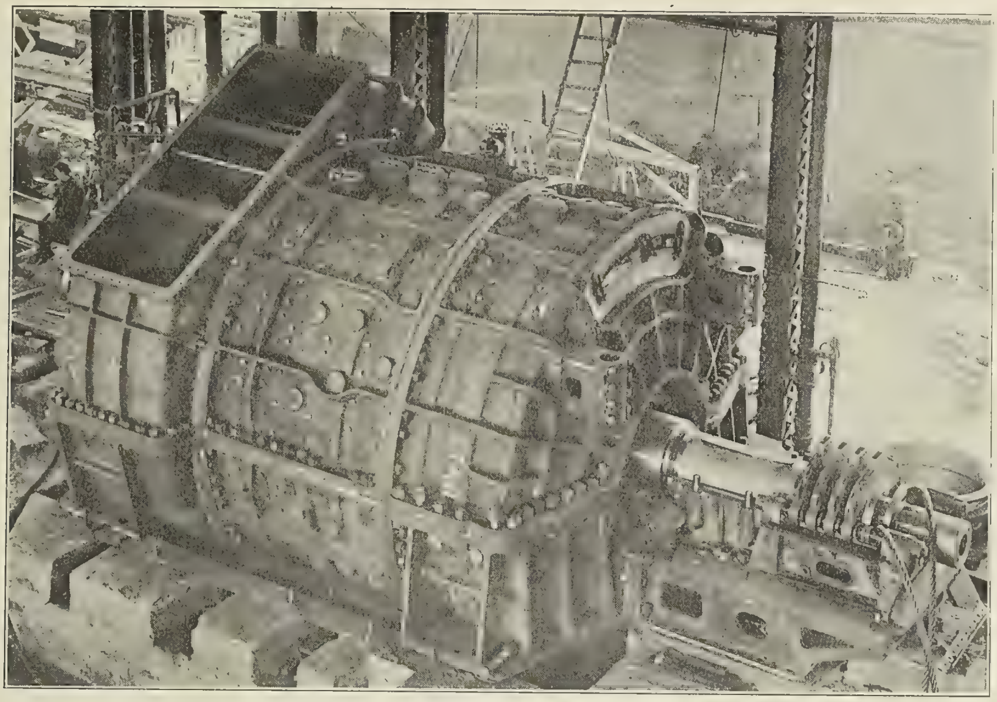


FIG. 8.—TURBINE ASSEMBLED IN BUILDER'S SHOP.

slight disturbance of the jet, which occurs at some distance from a nozzle or guide blade.

The steam pressure at the forward end of the drum approximately balances the thrust of the propeller, so that the thrust bearing is only required to take the resulting unbalanced thrust, which is comparatively small. The pressure distribution is proportioned to the area of the front of the drum to obtain this result.

A new form of turbine blading has been developed by the Fore River Shipbuilding Company, which is being used in the construction of the turbines for the *North Dakota*. The blades themselves, of which some 90,000 are required for both turbines, are of special bronze, accurately formed to the required shape by being extruded through a die. This stock is manufactured by a brass manufacturing firm in Connecticut for the special needs of turbine blades. These blades are cut to the required lengths, and the ends are milled to enter a steel channel-shaped base on one end and thin steel strips, called shrouds, on the other end. Details of the blades, channel-shaped bases and shrouds are shown in Fig. 3, as well as a section of blading which has been assembled.

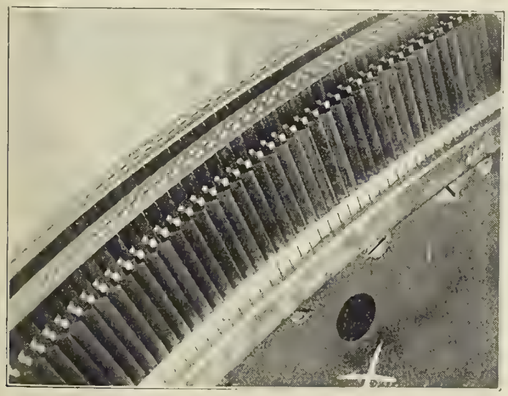


FIG. 9.—BLADING IN PLACE ON WHEE .

The channel-shaped bases are made in pairs on a duplex milling machine. This machine has a long table, which serves as a fixture to hold two sections of square stock, from which two backs are milled. After the bars have been milled they are placed in a special milling machine, on which a shallow V-shaped groove is milled in each side of the base. These grooves are for the purpose of fastening the bases to the rotor wheels into which they are later calked.

After the channel-shaped bases have been formed, the blades are riveted in place. This riveting operation is done by hand in a special riveting fixture or jack, shown in Fig. 5. A block is provided with a clamping jaw, so arranged that an individual blade will be grasped and held firmly in a vertical position. A strap clamp at the same time holds the base piece in its proper relation to this blade. When both blade and back are thus clamped in proper relationship one to the other the riveting is quickly and easily done. Various sizes of these

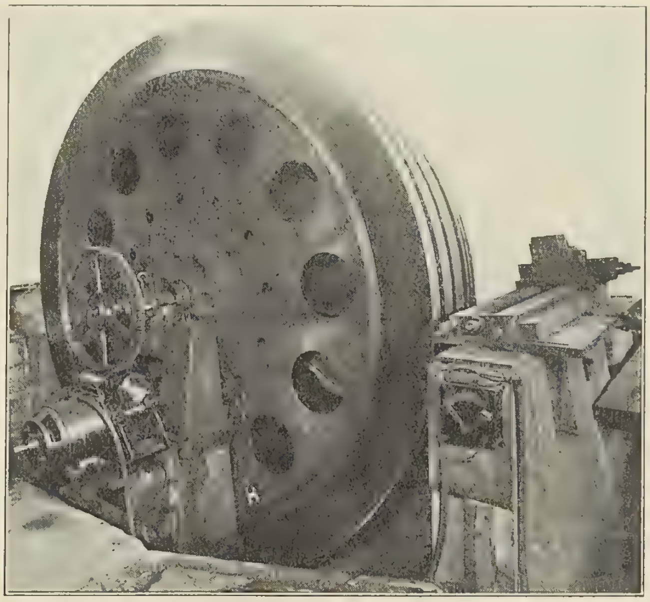


FIG. 10.—CALKING BLADING IN PLACE.

jacks are necessary, because the blades are not all of the same length.

After the blades have been riveted in place, the channel-shaped bases are placed on a special machine, where a series of cuts or slits is made through the legs of the channel-shaped piece. This is done in order to give the section of blading sufficient flexibility, so that the bases may be shaped to the positions which they are to occupy in both wheels and casings. This is a feature which has been largely responsible for the success of this new system of blading. The amount of flexibility gained in this way is shown by the section of blading in the lower part of the photograph, Fig. 3. This section has been supported at the center, and, as seen, conforms itself into a curve of comparatively short radius merely by the action of its own weight.

After the various sections of both moving and stationary blades are completed the turbine wheels are mounted in a horizontal position in a special machine for the operation of calking the blading into place and attaching the shrouding. The turbine wheels themselves are built up of circular discs of boiler plates in which lightening holes are cut, as shown in Fig. 10. To these discs are riveted and screwed cast steel rims. In the cast steel rims are turned a series of grooves of the proper size to receive the legs of the channel-shaped bases of the sections of blading. These sections of blading are placed in position, and the steel rim is then calked or staked down into the V-shaped grooves milled in the sides of the channel legs, thus holding the blading firmly in position in the wheel. It is stated that in tests a pull of some 9,000 pounds is required in order to loosen the blade after it has been properly calked in position. This, it is claimed, is more than ample to resist any stresses to which a blade might be put.

Fig. 10 shows the manner in which the blades are staked in position. In the part of the machine which has the appearance of a tool block is clamped a pneumatic hammer, in which a forked calking tool is placed. This tool straddles the blades and stakes over the edges of the rim into the grooves of the channel-shaped legs. The wheel itself is slowly rotated by power derived from the electric motor, shown in the illustration. At the same time the shrouding is placed in position over the milled outer ends of the blades, and the ends of the blades are securely riveted over. These various operations are clearly shown in Fig. 9, where three rows of blades are shown in place in the rim of a wheel; the ends of one set of blades are shown without the shroud in place; in the next row the shroud is in place, but the ends of the blades are not riveted over; while in the last row the ends of the blades are riveted over and the entire operation is complete.

The manner in which the stationary blades are secured in position is much the same as the moving blades. The sections of stationary blades are, however, fastened in place in the turbine casing by bolts. Fig. 1 shows the lower half of the exhaust casing with the blades in position, while the entire lower half of the turbine casing is shown in Fig. 6.

The steam is expanded in each stage through nozzles bolted to the diaphragm, as shown in the sectional drawing, Fig. 4. The diaphragms have steam port openings cast in them to allow the steam to pass through to the nozzles. The nozzles themselves are government bronze castings, cast in long, segmental shapes. The openings are cored in them and have a double taper. These nozzles, of course, must all be of an exact size, and have smooth surfaces. In earlier types of Curtis turbines this was accomplished by chipping and filing, which was a very expensive process. A special planing machine was, therefore, designed and built, by means of which this work is now done. As there are both right-hand and left-hand nozzles in a reversible turbine, it was necessary to incorporate in the machine facilities for planing either right-hand or left-hand nozzles.

REPAIRS TO THE FLORIDA.

The Italian Line steamship *Florida,* which sunk the *Republic* in collision off Nantucket, Jan. 23, was docked for repairs at the yards of the Morse Dry Dock & Repair Company, Brooklyn, N. Y. As shown by the photograph the bow of the *Florida* was crumpled up for a distance of about 40 feet aft of the stem. After the deck fittings had been removed the shell plating on each side of the vessel was cut down to the water's edge, about 2 feet back from the damaged portion, with pneumatic tools. After the waterline was reached the ship was placed in drydock, stern first. The water was then pumped out, and a 200-ton Monarch crane floated up to the end of the dock and the chains were made fast to the damaged bow.

THE FLORIDA IN DRY DOCK, SHOWING DAMAGED BOW.

The shell was then cut down through the keel on both sides, and the bow lifted bodily by the crane and taken away. The ship was then lowered off the dock, turned around and placed bow in, in order to bring the bow close to the shops and tools. The various strakes of plating were then cut back to the butts, and the new stem, frames and plates placed in position. The ship was then riveted to above the waterline, and lowered off the dock when repairs were completed.

This work was carried out with great facility, as the ship was delivered ready for cargo within twenty-four days. The steel stem, which was cast by the New Jersey Steel Company, Rahway, N. J., was delivered in four days after the pattern was received, which is one of the quickest jobs of steel casting which has come to our notice.

A steel, single-screw steamer, 195.5 feet long, with a beam of 43 feet and depth of hold of 19½ feet, is in service on the Great Lakes for salvage and repair of wrecked vessels. The vessel is fitted with a towing machine, derrick and grab bucket, diving apparatus and an exceptionally large pumping plant.

A SUCTION CUTTER DISCHARGING DREDGE FOR INDIA.

Messrs. William Simons & Company, Ltd., of Renfrew, have completed and shipped, to the order of the Secretary of State for India, a specially designed hydraulic dredge for the improvement of the waterways and for canal construction in the Bengal province. The dredger can open up a canal and deposit the dredged spoil on or over the canal banks. The vessel, which is named the *Alexandra,* is of the shallow draft type, with the hull structure arranged and suitably strengthened to resist machinery vibration when the full engine power is being exerted. The dimensions of the hull are 205 feet by 40 feet by 19 feet.

The suction pipe is carried by framework in a well forward. There is also attached to this frame the shafting and gearing for driving a Robinson's rotary cutter, arranged to work in advance of the suction orifice for pulverizing and disintegrating clayey material, which would otherwise resist the action of the suction pump. The suction frame is provided with a system of high-pressure water jets, for disintegrating compact sand which may not be resistant enough to call for the employment of the rotary cutter. Water for the jets is supplied from two special centrifugal pumps, in series, driven by an enclosed high-speed compound engine. The cutter is driven by bevel and spur gearing from an independent two-cylinder compound engine, placed on deck close to the well. Made of steel throughout, the cutter is, as stated, of Robinson's rotary type. It is designed to dredge hard clay or other difficult substance other than stones or rock, and is sufficiently strong to encounter immovable resistances without breaking. Should material, such as rock, be encountered, no breakage will occur; the engines will be simply brought to a stop, the working parts being sufficiently strong to take the strain.

The suction frame is controlled by independent hoisting gear, driven by two-cylinder engines, and when not at work, or when the dredge is under propulsion, the frame and the piping and cutter are hoisted clear above the water level. For purposes of mooring while at work the dredge has an arrangement of horns at the bow. These horns carry long, wire-rope blocks and tackle, which connect with tube mooring piles sunk under pressure in the sandy bottom of the canal or river, just as circumstances or the site of operations may require.

A centrifugal sand suction pump is situated a little forward of amidships. It is specially constructed with wide spaces to permit of the passage of large pieces of debris. All surfaces liable to the erosive action of the sand are fitted with adjustable wearing pieces. The suction pump is driven by an independent set of vertical triple-expansion engines of 900 indicated horsepower. The pump delivers the material dredged direct through a floating pipe line 600 feet in length. The pipe line leaves the dredge at the stern, and here there is a special swiveling connection, so arranged that the pipe line can be connected directly aft or on either side of the dredge.

The floating pipe line consists of circular pontoons, each carrying a discharge pipe, the discharge pipes being coupled together by special flexible connections.

HYDRAULIC DREDGE, ALEXANDRA, UNDER CONSTRUCTION AT YARDS OF WM. SIMONS & CO., LTD.

The vessel has two sets of vertical triple-expansion surface-condensing engines, each driving a propeller having four blades. The engines and propellers are designed to develop sufficient power for propelling the dredger at a speed of 9 statute miles per hour. Steam is provided by two cylindrical multi-tubular steel boilers, constructed to Lloyd's requirements for 160 pounds working pressure, reducing valves being fitted to suit the requirements of the auxiliary engines.

One main condenser is provided to take steam from all the engines on board, the condenser having a complete outfit of steam-driven air and circulating pumps. The auxiliaries include a vertical, long-stroke feed pump for boiler supply, with automatic control gear; two vertical duplex general service and bilge pumps; two feed-water filters, each arranged so that the other can be overhauled when the dredger is at work, and an evaporator for providing fresh water. The vessel has also a complete electric light installation. There is a workshop on deck, equipped with a forge and a number of machine tools, so that, irrespective of the position of dredging operations, repairs may be speedily effected on board without recourse to workshops on shore. Telegraphs are fitted from the operating bridge of the dredger to all working parts, so that one man standing on the bridge can control all operations.

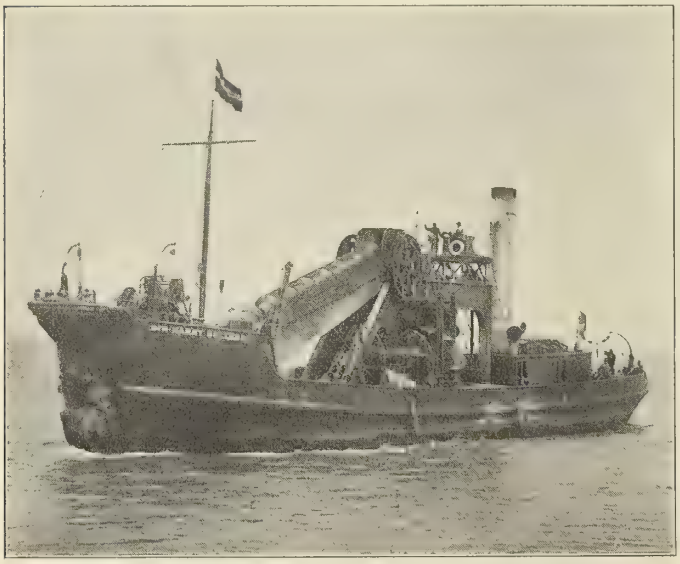
THE SIR HARRY BULLARD.

The twin-screw, combined barge-loading and hopper dredger, *Sir Harry Bullard,* recently launched from Messrs. Ferguson Bros.' yard at Port-Glasgow, has carried out her dredging and speed trials on the Firth of Clyde. The vessel loaded her hopper in forty-five minutes at Port-Glasgow harbor, and afterwards proceeded to the measured mile, where, on four runs with and against the tide, a mean speed of about 8 knots was obtained, being half a knot in excess of the contract.

The vessel has been built to the order of the Great Yarmouth Port and Haven Commissioners, under the direction of Messrs. Coode, Son & Matthews. Her dimensions are:

Length	172 feet.
Breadth	31 feet.
Depth, molded	13 feet.

The dredger is of the bow-well type, arranged to cut her own flotation, having a central hopper. Discharging shoots



TWIN SCREW COMBINED BARGE LOADING AND HOPPER DREDGER.

are fitted for self or barge loading; the navigating bridge is placed on top of the framing, and is fitted with a steam steering gear, a Lord Kelvin compass, and Chadburn's repeating telegraph.

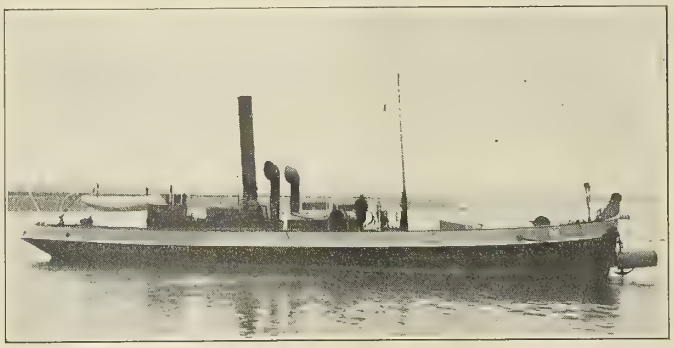
The machinery consists of two sets of compound surface-condensing vertical engines of 800 indicated horsepower, both engines exhausting into a large condenser, having an independent circulating pump and Edwards' air pumps. Steam is supplied by two marine tubular boilers fitted with corrugated furnaces.

Powerful triple-barrel, double-cylinder mooring winches are fitted at the bow and stern for manipulating the mooring chains, Chadburn's telegraphs being fitted to transmit orders to these winches. The hopper doors are controlled by friction winches of the latest type, each winch having an independent engine, the worm wheels being of gunmetal and the barrels of cast steel.

The gear for raising the bucket ladder is of massive design, capable of handling the ladder with steam at 50 pounds pressure, the working pressure being 120 pounds per square inch; compound brakes are fitted, also a double-cylinder engine, complete with governor and controlling levers. The spur and bevel wheels throughout the vessel are of cast steel, the upper tumbler shaft having double-friction spur wheels of large diameter. The buckets are of a design to facilitate the free discharge of clay, the backs are of cast steel, the bodies of steel plates and the wearing lips hard steel forgings, and are riveted by hydraulic power. The links and pins are of special quality steel for hard wear.

The Suction and Force Pump Dredger Po.

The *Po,* built by Werf Gusto, Shiedam, Holland, in 1908, to the order of the Italian Government, is a seagoing twin-screw suction and force-pump dredger, designed for deepening the river Po. The principal dimensions are: Length, 98 feet 5



THE PO.

inches; breadth, 19 feet 7 inches; depth, 7 feet 3 inches; capacity, 555 cubic yards an hour. She is capable of dredging material from a depth of 23 feet. The spoils can be forced away to a distance of 330 feet through a floating conduit resting on small pontoons fitted with anchors. This conduit has been specially designed for resisting the strong currents which prevail in the River Po.

SUCTION DREDGER FOR NEW ZEALAND.

In the yards of William Simons & Company, Ltd., Renfrew, Clyde, a large twin-screw, stern-well, combined bucket suction and discharging dredger, named the *Mawhera,* has been built for the Greymouth Harbor Board, New Zealand. The dredger was launched with all its machinery on board complete and ready for work.

The hull and machinery were built to Lloyd's highest class. The bucket and pump dredging outfit embodies all the most modern improvements, and is provided with all the appliances necessary for reclaiming land. The bucket ladder is arranged so that the bucket can dredge close up to quay walls, and also cut the dredger's own flotation. The discharging pump is arranged to receive and deliver, through a long length of floating and shore pipes, the material dredged by the suction pump or buckets.

Propulsion is by means of two sets of triple-expansion, surface-condensing engines, each driving its own propeller. Steam is supplied from two steel boilers, constructed to Lloyd's and Board of Trade requirements, for a working pressure of 160 pounds per square inch. The propelling engines are also arranged for driving the bucket chain at two different speeds, and the suction pump and discharging pump, either in conjunction with the buckets or separately, as required.

The auxiliary outfit includes independent automatic feed pumps, bilge pumps, service pumps, circulating pumps, condenser, feed heater and filter. The dredging machinery is of very massive design for dealing with hard material, and all parts of the gearing and bucket chain are of special hard and durable steel, to reduce wear and tear to a minimum. Independent steam hoist gears are provided, both for ladder and suction pipe. The mooring winches at the bow and stern are exceptionally strong.

RECLAMATION DREDGERS FOR BOMBAY.

Messrs. William Simons & Company, Ltd., Renfrew, have just completed two extremely powerful suction pump and discharging dredgers, to the order of the Bombay Port Trust. The dredgers, which are named *Jinga* and *Kalu,* are each fitted with what is claimed to be the most powerful pumping plant afloat, designed to dredge 2,700 tons of material per hour, and discharge same through a floating pipe line, fitted with steel ball and socket joints and land pipes to a distance of upwards of 4,500 feet from the side of the dredger. These vessels will be employed upon an extensive reclamation scheme at Bombay, and have been constructed under the direction of Sir J. Wolfe Barry and Mr. A. J. Barry, M. M. Inst. C. E., consulting engineers in London to the Bombay Port Trust, and Mr. George Turner, resident inspecting engineer. It is estimated that by the operations of the two dredgers, under the present scheme alone, an addition of about 4½ percent will be made to the area of the city of Bombay.

Both dredgers will proceed to Bombay under their own steam, and for this purpose two sets of compound surface-condensing engines are provided, capable of driving the vessels at a speed of 8 knots. The pumping outfit consists of very large centrifugal suction and discharging pumps, directly coupled to triple expansion surface-condensing engines. A large condenser is fitted to take the exhaust steam from all engines on board. Steam is supplied from four very large cylindrical multi-tubular boilers, constructed to Lloyd's full requirements and fitted with Howden's patent forced draft. The boilers are specially designed for burning inferior Indian coal. A very full equipment of engine room auxiliaries is provided, including independent circulating pumps, independent automatic feed pumps, independent bilge and general service pump, feed heater, filter, evaporator, etc.

A spiral rotary cutter is fitted at the lower end of the suction frame, driven by steel spur gearing by a set of compound surface-condensing engines. The suction frame is controlled by independent steam hoisting gear. Bow and stern winches of particularly powerful construction, arranged for rapid handling of wire-rope moorings, and anchor cables are provided. The control of the dredger is centered on the operating bridge, on which are placed all telegraphs, speaking tubes and signals to the cutter engines, pump engines and stern winch, also the handles for controlling the frame hoisting gear and the bow winch. One man can thus control and direct all the operations of the dredger and the pipe line. The living accommodation and the general arrangements are all designed for a vessel working in a tropical climate, every attention having been given to light and ventilation.

The vessels are electrically lighted throughout, having a powerful searchlight for manipulating the dredger's pipe line when working at night. Telephone communication between the dredger and the end of the pipe line is also provided.

THE JINGA, SHOWING ROTARY CUTTING GEAR.

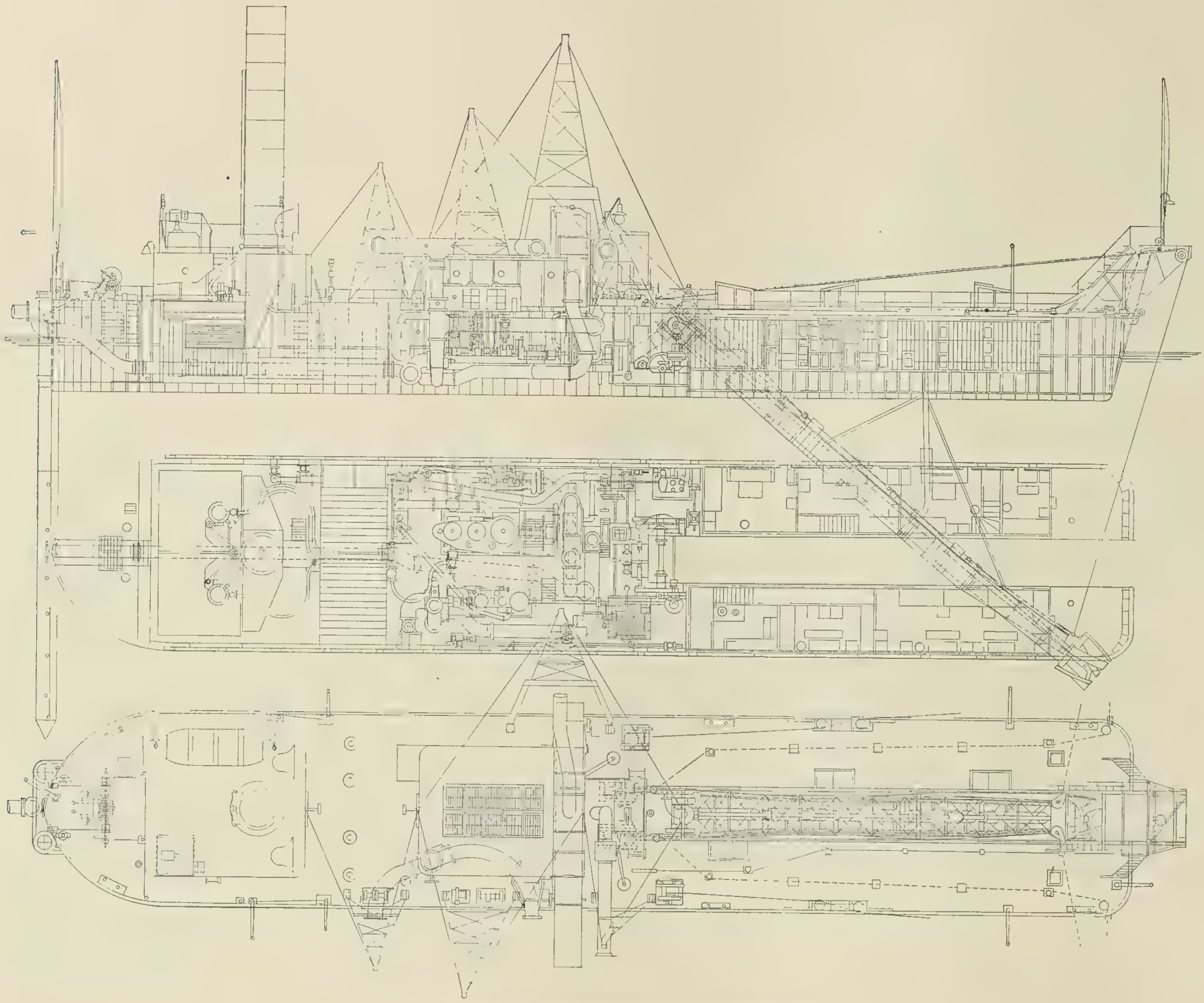
A GERMAN SUCTION DREDGER.

Suction dredges in which the soil is drawn up from the bottom by suction and then forced overboard are largely used at the present time, principally on account of the economy which can be effected by their use. This is due, first, to the small working expenses, which are considerably less than those required for a bucket dredger, and, second, on account of the cost of repairs, which is also less than in the case of a bucket dredger, where there are so many parts which are subject to hard wear and tear. These considerations, taken in connection with the first cost and depreciation, make the suction dredger an economical piece of apparatus.

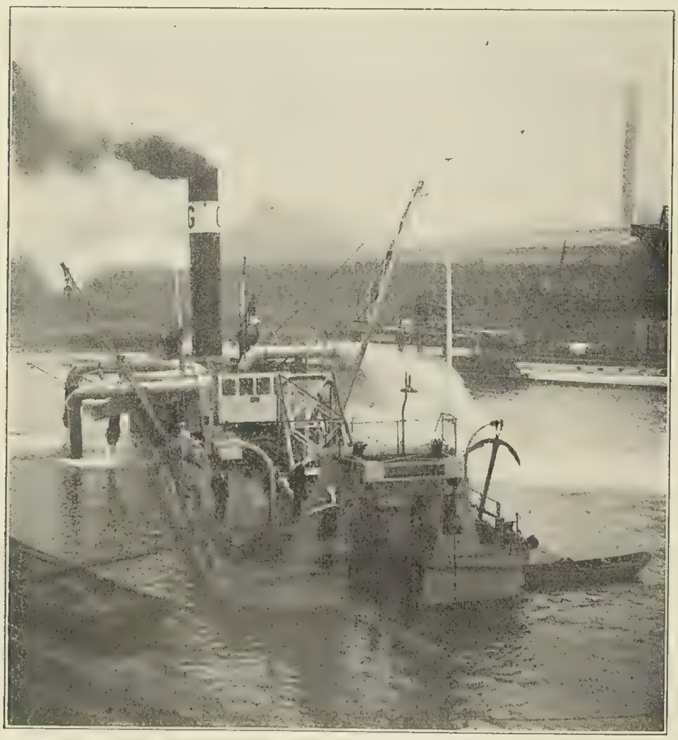
In soft soil the suction of the pumps is sufficient to loosen the material and draw it through the suction pipes, while in hard material it is necessary to break up or cut the soil before it can be sucked up by the pumps.

The illustrations show a suction dredger built on this principle by the Gebrüder Sachsenberg A. G., in Rosslau, Germany, for the Gebrüder Goedhart A. G., Düsseldorf. This dredge has a capacity of 17,660 cubic feet per hour in hard material, with a dredging depth of 46 feet, and is capable of forcing the soil through a distance of 3,281 feet. The principal dimensions are: Length between perpendiculars, 149.8 feet; breadth over the frames, 26.25 feet; molded depth, 11.5 feet; draft in working condition about 7 feet.

The hull is built of mild steel to the highest class Germanischer Lloyd's, and where necessary, as in the machinery foundations, special reinforcement is provided. The vessel has a steel deck and also steel deck houses over the boiler and engine rooms, built up of plates and angles. On account of the opening for the suction pipe in the center of the vessel forward, there are really two intercostal keelsons. These divisional bulkheads, together with five transverse bulkheads,



PROFILE AND DECK PLANS OF GERMAN SUCTION DREDGE.



GERMAN DREDGE IN OPERATION.

divide the hull into six watertight compartments. A double fender of oak, 11.8 by 5.9 inches, extends entirely around the hull, and is fastened to the shell by heavy angle bars. There are also vertical fenders of the same dimensions every fourth frame space.

In the living quarters, which are in the forward part of the vessel, there are cabins for the dredge master, one for the two chief engineers, one for the two second engineers, one for one assistant, one for four firemen, and one for the crew. There is also a galley, pantry, storeroom and chain locker in this part of the vessel.

The arrangement of the suction pipe, the windlass for operating it, and the cutting apparatus is shown in the plan and profile drawings. This pipe, when dredging at a maximum depth of 46 feet, has an inclination from the horizontal of about 42 degrees. Its construction consists essentially of two plate girders with the necessary cross and diagonal bracing of angle bars and plates. This pipe is movable about a horizontal axis, and is connected through a stuffing-box in the port longitudinal bulkhead to the pipe leading to the suction pump. The cutting apparatus at the end of the suction pipe is operated through bevel gears from one of the main engines of the dredge. The apparatus itself consists of five knives fastened in a cast steel head, the outer end of the knives being fastened to a five-armed or star-shaped casting, to afford strength and rigidity. The knives are 12.6 by 1.77 inches by 4.92 feet long.

The arrangement of the boilers, pumps and engines is clearly shown on the drawings. The suction pipe leads first

to the suction pump, thence leading to the force or pressure pump. All the pumps are of the centrifugal type, and are direct connected to steam engines. The suction pump is built by Nagle & Kaemp A. G., Hamburg, and has a bucket wheel 90.55 inches in diameter fixed to a shaft 8.66 inches in diameter. The force pump, which is supplied by the same firm, has a bucket wheel 41.73 inches in diameter. The air and circulating pumps, the latter for the circulation of water in the condenser, are also direct connected to steam engines. The engine for driving the suction pump is of the triple-expansion, vertical type, with cylinders 16.14, 26.38, 40.55 inches in diameter and 19.69 inches stroke. At a speed of 220 revolutions per minute it is capable of developing 900 indicated horsepower.

The force pump is also connected to a triple-expansion, vertical engine, somewhat smaller than the other one. This engine has cylinders 11.81, 18.9, 29.53 inches in diameter with a stroke of 13 inches, and at 210 revolutions per minute develops 300 indicated horsepower. This engine also drives the shaft for operating the cutter. The air and circulating pumps are driven by a two-cylinder high-pressure steam engine.

Steam is generated at a pressure of 190 pounds per square inch in two cylindrical, return tubular boilers of the marine type, each boiler having 1,937 square feet of heating surface. The boilers are 11.5 feet long, 11.15 feet diameter, and each has two corrugated furnaces 45.28 inches mean diameter, as well as 200 ordinary tubes 3 inches outside diameter, No. 10, B. W. G., and sixty-four stay-tubes 3 inches outside diameter, No. 1, B. W. G. The feed and auxiliary pumps include one feed pump, one duplex steam pump, one injector, one hand pump, one ejector. There is also an evaporator and an oil separator. With the exception of the bilge pipe all pipes are of copper, and where necessary are provided with means for draining off the condensed water. All pipes leading outboard have stop valves. All steam and hot-water pipes are carefully lagged.

THE FRUHLING SYSTEM OF SUCTION DREDGING.*

In any attempt to improve the efficiency of the suction dredge an effort must be made not merely to loosen but also to secure the material by a mechanical cutting of the surface, and also to control the inrush of water at the suction pipe entrance. To achieve either of these results is to greatly improve the suction dredge. Otto Fruhling, of Braunschweig, Germany, a contractor, dredge operator and designer, has developed a new system of suction dredging which fulfills the above desiderata and possesses other features of great value.

His system consists of fitting a large inverted dipper-dredge bucket on the bottom end of the suction pipe to scrape up and collect the dredged material before the suction forces come into play. It was to be expected that the addition of the broad bucket head, with its ponderous weight and sharp cutting edge, would produce a greatly increased supply of sand and mud to the suction pump, but it was hardly anticipated that the action would be such as to completely bar the admission of the surplus water; yet such was found to be the case, and to such an extent as to require the fitting of pressure-water connections to the inside of the bucket head, so that sufficient water might be pumped in at will to liquefy the solid material and bring it to such a consistency as would enable the suction pumps to handle it. Small valves added to the head, permitting a certain flow of the surrounding water at the will of the operator, were also fitted.

In the interior of the scraper head, before the dredged material comes into range of the suction, it is forced into a mixing chamber, where the dredgings are reduced to a uniform consistency by the pressure water or by the mere admission of outside water. From the mixing chamber the material is drawn through the pumps and is discharged into the hopper.

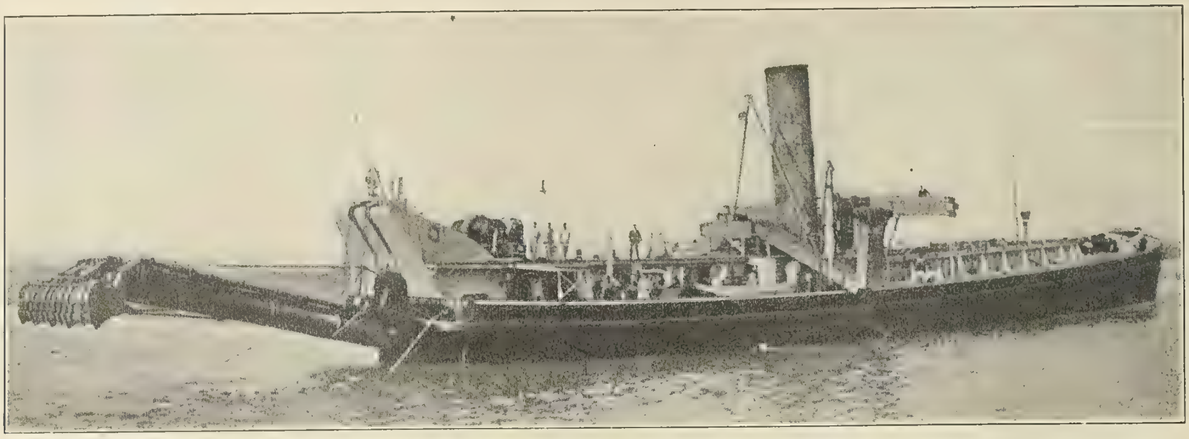
* Abstract from an article by John Reid in "Engineering News."

The largest dredge of this type yet built is *Dredge VII.*, belonging to the German government and employed in widening and maintaining the approach channels through the Jade Estuary to the great North Sea naval station of Wilhelmshaven. This vessel (Fig. 1), built by F. Schichau, Elbing and Dantzic, Germany, will serve to illustrate the construction and operation of the Fruhling dredge. The principal dimensions of *Dredge VII.* are: Length, 265 feet; breadth, 48 feet; depth, 20 feet. There is one large hopper forward of the machinery space, with a total capacity of 2,000 cubic yards, provided with bottom doors for discharging the dredgings by dumping. The propelling and pumping machinery consists of four sets of triple-expansion engines, each unit of 500 indicated horsepower. These four units are arranged tandem, two on each bedplate, and drive twin screws. The two aftermost engines are coupled direct to the propeller shafts and two forward units to the suction pumps. When it is desired to exert full power (2,000 indicated horsepower) on the propellers, as when steaming at sea or to a dump with a load, a clutch mechanism connects the forward and after units on each bedplate. In dredging only the after pair of engines are used for propulsion, while a speed usually of from 4 to 5 knots over the ground is maintained, and the forward pair of engines drive the pumps. All four engines exhaust to a central condensing installation with separate air, feed and circulating pumps. The arrangement lends itself to great economy, the coal consumption working out at the surprising figure of 0.85 pounds per indicated horsepower per hour over long periods of work.

The suction pumps are two in number, each with a diameter of 5 feet 2 inches. When working in mud the speed of the pump is about 200 revolutions per minute, and when working in sand is 140, both figures, of course, being variable. The design of the pump is a very important element in the success of the Fruhling dredge, and it may be said, briefly, that the characteristic features are small diameter, high speed and small clearances.

The most striking features of the Fruhling dredge are the arrangement of the suction arm and the bucket head. In *Dredge No. VII.*, and in most other dredges of the type, the hull is cut in two by a narrow fore and aft channel or well, terminating just abaft the after pair of propelling engines. At the forward end of this well, at about the level of the water-line, a massive pillow-block on each side supports a pair of hollow trunnions, by which is supported the heavy bridge-girder frame, which carries the suction and pressure pipe and bears the stresses coming on to the dredging head. At the lower end of the girder is a huge pair of hinges, by which the bucket head is attached, so that it has a movement of rotation about a horizontal axis at right angles to the direction of the girder, to enable the cutting angle to be varied at will. The hinges are hollow, and through them the suction pipes enter the bucket. This latter is made of steel castings bolted together, and is 16 feet 6 inches broad by about 5 feet in depth. It has a cutting edge studded with hollow teeth, through which jets of pressure water can be ejected to help break up tough material. There are also baffle plates to reduce the size of the entrance, and a series of bars to form a grid and prevent the admission of undesirable objects.

The operation of the Fruhling dredge is briefly as follows: The heavy head is dragged over the bottom at a speed of 4 of 5 knots. It scrapes or plows off a strip as wide as itself, from 12 to 18 feet, and from 12 to 18 inches in depth. The material as it is plowed up is forced into the head by the pressure of the scooping action. Here it is kneaded, mixed and liquefied, as may be found necessary, and finally is sucked up by the pump. The action is quite continuous, but is in

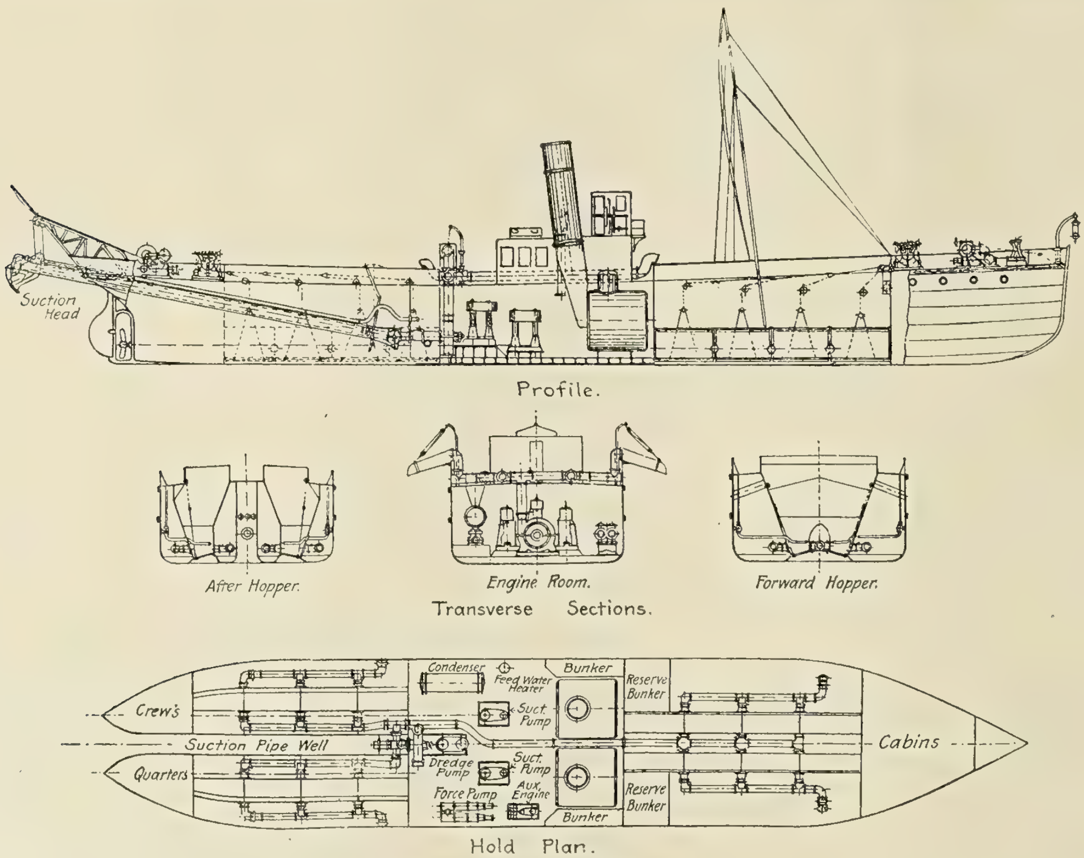


DREDGE NO. VII.

two distinct stages: first, the mechanical cutting and mixing and then the removal by suction, the suction forces acting entirely inside the head and not outside of it, as in the ordinary dredge.

In her trials *Dredge No. VII.* greatly exceeded anticipations. The contract called for a pumping capacity per hour of 4,500 cubic yards in soft ground. The actual result on trial was 6,500 cubic yards (about 7,700 tons); in heavy, sandy ground with connections to a long shore-pipe line is necessary, or with the hopper dredges it is necessary to dump alongside a stationary dredge and repump, with a consequent loss of time, material and money.

This is obviated in the Fruhling design. A suction pipe extends along the center of hopper through the hollow center girder and communicates with the interior of the hopper through lateral branches. Opposite to these branches on the



DETAILS OF DREDGE NO VII.

(specific gravity, 1.96) the dredge excavated 4,680 cubic yards, the proportion of solids in the discharge being 65 percent.

A secondary valuable feature of the Fruhling dredge is the method by which the hopper contents can be sucked back through the pumps and discharged on shore through a swiveling deck pipe, by means of which a temporary connection to a shore line of pipes can be made. Hitherto hopper dredges have had to dump through the bottom doors. If it is desired to use the dredgings for reclamation either a special dredge hopper sides are similar branches connecting with fore and aft pipes having sea inlet connections through the ship's side. When the hopper is charged and it is desired to repump its contents, which may have packed very firmly, the sea inlet valves are opened, admitting water into the wing pipes. On opening the valves in the lateral branches and starting the suction pump, water is drawn across the openings between the branches. This rush of water carries the dredgings lying between the pipe branches, and the superincumbent masses of

material gradually fall down and are sucked into the pumps. The pump discharges through a rising pipe into the swiveling deck pipe, shown in Fig. 2, by means of which temporary connection is made to a shore pipe line. It has been found that approximately the same time is taken to pump the hopper load ashore as was spent in dredging it. Further, the dredgings, as dropped from the shore-pipe end, are in the semi-fluid form, and there is no rush of excess water as with the ordinary shore-pumping methods.

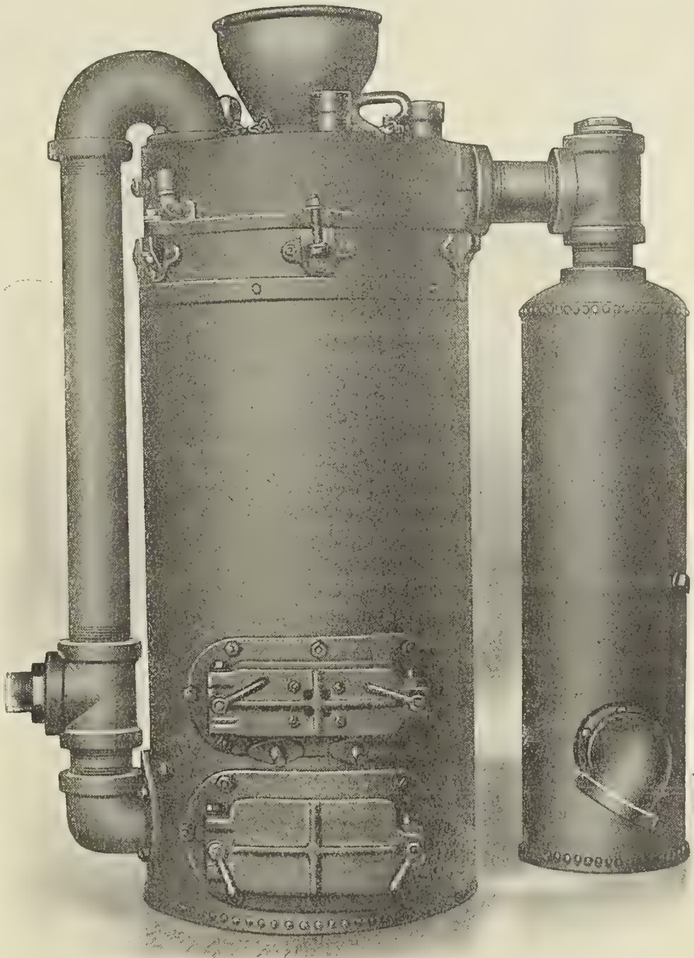
In the practical use of the Fruhling dredge several secondary advantages conduce to greater economy and efficiency. For example, the dredge normally operates at a speed of 4 to 5 knots over the ground; it is, therefore, always under good steerage way, and can avoid passing vessels and maintain a fair course against tide and wind. In addition, the action of the cutting head, free from any suction influences, is to leave the surface dredged level and clear of over-depths and side or under cuts. The ordinary suction dredges frequently leave deep pits and high ridges in the dredged channel, and their operation near dock walls or loaded wharves often involves a serious risk of undermining such work. Slipping of dock walls from this cause has actually happened.

A GAS-PROPELLED MOTOR BOAT.

About two years ago, Mr. Gray, president of the Mianus Motor Works, Mianus, Conn., designed a 25-horsepower marine gas producer for installation in a small motor boat. As compared with the ordinary gas producer used for stationary power plans, this producer effects a great saving in space, at the same time maintaining the efficiency of the stationary type. The saving of space is effected by the design of the scrubber, which is only one-quarter the size of the generator, whereas, in ordinary stationary plants, the scrubber is usually about twice as large as the generator. Salt water is used in the scrubber instead of fresh water, making the entire apparatus easily available for ocean-going travel.

The grates in the generator are arranged to shake and dump without opening the doors. The entire plant is thus made as simple and easy to operate as possible.

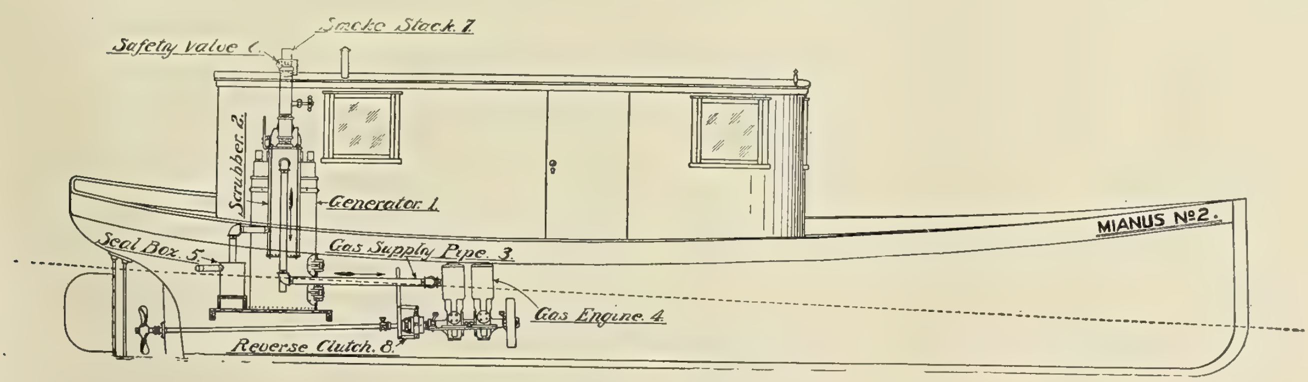
The boat has been in service since July, 1908, principally on Long Island Sound. The operation of the producer has been found to be excellent in all kinds of weather, and the cost of operation, when using hard pea coal, is only about 27 percent of the cost of the same plant operating with gasoline. An average of from 1 to 1¼ pounds of coal per horsepower-hour is consumed, and, in the 25-horsepower plant, assuming a maximum of 1¼ pounds of coal per horsepower-hour, the consumption for ten hours would be 313 pounds, and with coal at $6 (£1.25) a ton, the total cost would be 94 cents (£0.19). The same size motor operating on gasoline would require 1/10 of a gallon of gasoline per horsepower-hour, or a total of 25



GAS PRODUCER AND SCRUBBER.

gallons for ten hours, making a total cost at 14 cents a gallon of $3.50 (£0.72).

The space occupied by the 25-horsepower producer is 4 feet by 6 feet; the height over all, 5 feet, and the total weight is 1,200 pounds.



GENERAL ARRANGEMENT OF MIANUS MOTOR BOAT.

INTERNATIONAL MARINE ENGINEERING

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Dredges.

Although dredges form only a small part of the total tonnage of shipping produced each year, yet on account of the important part which they play in the navigation of rivers and harbors their design and construction should be carefully considered by shipbuilders and marine engineers. Like many other pieces of floating apparatus, early types of dredges were developed largely by contractors or engineers who were chiefly concerned with the work which the dredge was to perform rather than with the vessel in which the apparatus was to be installed. Consequently, early types of dredges usually consisted of some form of bucket or dipper conveniently placed on a scow with means for raising and lowering the bucket and discharging the contents into a barge. As dredging operations became more extended the apparatus naturally increased in size, although the general principles remained the same. As a matter of fact, the scow type of hull is not well adapted to dredger construction. The design of a dredge involves the placing of heavy machinery in various parts of the hull, as well as providing for the excessive strains set up in the structure due to the operation of the dredge. These strains, due primarily to the thrust of the ladder, must be provided for by a thorough system of longitudinal and athwartship bracing in the hull, and all the machinery requires secure foundations, which should form a part of the hull structure itself. These facts are best appreciated by a marine engineer, and the best results can obviously be secured when both hull and machinery are designed with a view to their relative requirements and limitations.

Sea-going bucket dredges are usually of the sternwell type, in which the dredging apparatus consists of a series of buckets operating on an endless chain through a well located on the center line of the boat, either at the bow or stern, as may be desired. The design of dredges of this type more nearly approaches ordinary steamship design, and such dredges are built of large size and great power, some of the most recent ones being over 300 feet long. The most common type of sea-going dredge, however, is the suction dredge, and the introduction of this type is undoubtedly the most important departure in design that has yet been introduced.

Until recently suction dredges have been of comparatively small size, capable of handling a few hundred tons of material an hour; nearly all operated on the same general principle—that is, a suction pipe 18 or 20 inches in diameter fitted with some form of scraper or suction head, capable of being raised or lowered, and either dragging after the vessel or projecting forward from it, is connected to a centrifugal suction pump which draws a comparatively large volume of water into the suction head and along with it a certain amount of the mud or sand which is to be raised. The contents of the pipe are then forced into the hopper of the vessel or into a barge alongside, where the mud and sand settle to the bottom of the hopper and the water is allowed to overflow. Some form of rotary cutter is usually provided in the suction head in order to break up hard or clayey substances, so that the suction forces will draw the material into the pipe.

It is obvious that this type of dredge is inefficient in operation from the fact that, with every cubic yard of material raised by the pump, a great quantity of superfluous water must also be raised only to be discharged again. Frequently, too, much of the solid material which is raised by the pump escapes with the overflow water, so that in some of the largest and most up-to-date dredges of the hopper type it has been found that oftentimes in service in certain kinds of material only about one-tenth of the power expended at the pump is actually realized in raising solid material which can be secured in the hopper. Apparently the most successful attempt to overcome this waste is found in the Fruhling system of suction dredging, where the end of the suction pipe is provided with an inverted dipper or bucket, which scrapes up the material and brings it to the suction head before the suction forces are allowed to act upon it. By means of this system it is claimed that the solid material can be

raised without at the same time raising a large percentage of water. It is claimed that the material as it leaves the discharge pipe is a dense black or gray semi-fluid similar in consistency to mortar. In soft mud and earthy material it has been found possible to pump and secure in the hopper about 90 percent of the solid material, whereas in the former type of suction dredge 15 or 20 percent was considered highly satisfactory. Even in coarse or hard sand it has been found possible to secure 50, 60 or even 70 percent of solid material.

The remarkable development in the size of suction dredges is apparent when it is considered that the latest addition to the fleet consists of a vessel 500 feet long, capable of raising 10,000 tons of material from a depth of 70 feet below the water level in fifty minutes. Reciprocating engines direct connected to the pumps and cutter mechanism, winding machines, etc., are usually employed for power purposes. In self-propelled, seagoing dredges the main propelling engines are frequently installed so they can be disconnected from the propeller shafts and connected to the pump shafts by clutches, so that the same engines can be used for both purposes. Electricity has been used to a certain extent, but not very widely, in operating dredges. The facility of transmission and ease of control will be important factors in its successful application to this work. Chains have almost entirely disappeared from dredges, and wire rope has been substituted in their place. Wire rope not only runs more smoothly and with a great deal less noise, but also gives warning when there is a possibility of breakage, something which does not occur when chains are used.

Naval Boilers.

Not so very many years ago the British Admiralty made the costly experiment of installing in its war vessels almost exclusively a single type of watertube boiler. This was done before it had been conclusively proved that the boiler adopted possessed superior advantages over other types of boilers then in existence. The result of the experiment was that after a short period of service this type of boiler was abandoned as unsuitable for naval purposes, and, wherever it was possible to do so without entailing too great expense, other boilers were substituted for them in ships then under construction. It is doubtful if any nation will ever again give any particular type of boiler such an extensive trial as this without first making careful comparative tests. It has been the policy in nearly every case to adopt a certain type of boiler only after its advantages have been conclusively proved by comparative results with other types of boilers.

A splendid opportunity was given in the recent around-the-world cruise of the American battleship fleet to compare the results of four different types of boilers under cruising conditions. One of these types, namely, the Scotch boiler, need hardly be considered in the results, as the question of weight now practically prohibits the use of Scotch boilers in naval vessels, notwithstanding their excellent economy and durability, and it is likely that those now fitted will soon be replaced by watertube boilers. Leaving out of the question the Scotch boiler, interest centers in the relative advantages and disadvantages of using large tube and express boilers. The results of observations of the performance of the boilers made on the cruise of the American fleet, as stated by one of our correspondents elsewhere in this issue, are valuable in this connection. The figures given for economy of coal consumption are, of course, very general, as no attempt was made to analyze the efficiency of propellers, engines and boilers, and without more definite data the actual comparative efficiency of the boilers could not be stated exactly. The main point brought out by our correspondent—and, perhaps, after all, the most important point to be considered—is the question of maintenance and repairs. In general, the express type of boiler, although permitting a slight reduction in weight, is more inaccessible for general repairs than the large tube boiler; consequently, the large tube boiler can be kept in a better state of readiness for service, and while scaling, corrosion and deposits of soot, grease, etc., may not be more prevalent in the one type than in the other, yet their effects seem to be less harmful in the large tube boiler than in the express type, chiefly for the reason that the large tube boiler can be more easily cleaned and inspected, and when necessary defective parts can be readily replaced in a short time by the fire-room force. Any boiler that can be easily cleaned and repaired without the necessity of taking the ship to a navy yard possesses an advantage which for military purposes cannot be overestimated, as the boiler can then be kept in the best of condition and will always be in shape to respond to forcing. The durability of boiler casings, while not as important as the durability of the boiler itself, is also an important point in naval vessels.

The economy when steaming at full power and the ability to stand forcing are not considered in this article, since the observations were made almost wholly at cruising speeds. Small tube or express boilers naturally permit of forcing to a higher rate of evaporation per square foot of heating surface than large tube boilers; but, at the same time, this result is obtained at the sacrifice of durability and accessibility for repairs. The question of the use of a more rugged type of express boiler, or one which might be termed a semi-express boiler, capable of withstanding rough usage, and, at the same time, capable of being forced to a high rate of evaporation per square foot of heating surface, has been brought forward tentatively from time to time; but as no boilers of this type are installed on any United States battleship, there is no opportunity to make a satisfactory comparison of their performance with the other boilers.

Progress of Naval Vessels.

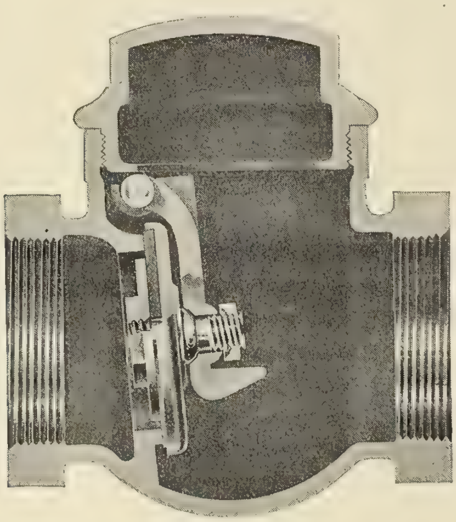
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Mar. 1.	Apr. 1
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons.........	82.3	86.9
Michigan ...	16,000	18½	New York Shipbuilding Co...	93.0	95.2
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	68.5	73.0
North Dakota	20,000	21	Fore River Shipbuilding Co...	74.5	77.9
Florida	20,000	20¾	Navy Yard, New York......	4.8	8.4
Utah	20,000	20¾	New York Shipbuilding Co...	5.6	10.8
TORPEDO-BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons..........	67.8	71.4
Lamson	700	28	Wm. Cramp & Sons..........	66.3	69.4
Preston	700	28	New York Shipbuilding Co...	60.2	64.1
Flusser	700	28	Bath Iron Works............	60.6	63.2
Reid	700	28	Bath Iron Works............	60.0	63.0
Paulding ...	742	29½	Bath Iron Works............	5.0	7.0
Drayton	742	29½	Bath Iron Works............	5.0	7.0
Roe	742	29½	Newp't News Shipbuilding Co.	17.6	29.5
Terry	742	29½	Newp't News Shipbuilding Co.	17.1	27.4
Perkins	742	29½	Fore River Shipbuilding Co...	11.7	15.7
Sterrett	742	29½	Fore River Shipbuilding Co...	11.7	15.7
McCall	742	29½	New York Shipbuilding Co...	8.2	10.5
Burrows	742	29½	New York Shipbuilding Co...	8.1	10.0
Warrington..	742	29½	Wm. Cramp & Sons..........	8.4	12.4
Mayrant	742	29½	Wm. Cramp & Sons..........	8.1	12.2
SUBMARINE TORPEDO BOATS.					
Stingray	...	..	Fore River Shipbuilding Co..	77.5	82.0
Tarpon	...	..	Fore River Shipbuilding Co..	76.2	81.7
Bonita	...	..	Fore River Shipbuilding Co..	71.5	76.7
Snapper	...	..	Fore River Shipbuilding Co..	71.0	76.3
Narwhal ...	...	..	Fore River Shipbuilding Co..	74.4	84.2
Grayling ...	...	..	Fore River Shipbuilding Co..	70.7	77.8
Salmon	...	..	Fore River Shipbuilding Co..	64.2	66.6
Seal	...	..	Newp't News Shipbuilding Co.	4.6	8.8

ENGINEERING SPECIALTIES.

The Nelson Bronze Swing Check Valve.

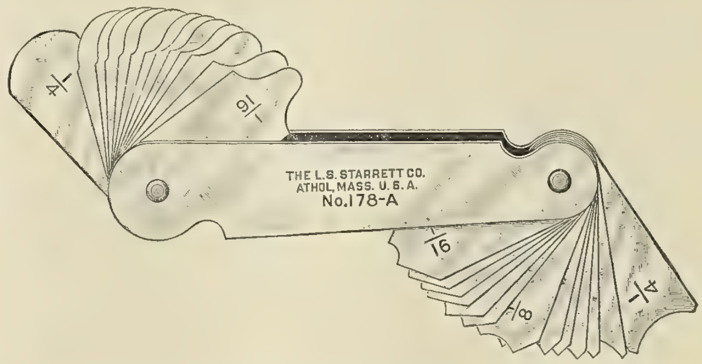
The valve illustrated is designed for working pressures up to 125 pounds per square inch, each valve being tested to 250 pounds. For steam service this valve has a bronze disc fastened to a self-hinging clapper. When used for hydraulic work, the valve has a leather disc, kept in place by means of a bronze disc retainer. The body is cast in one piece and



the bearing for the clapper is cast in the valve body. The ball and socket joint between the disc and the clapper provides free movement, so that the back pressure causes the valve to seat perfectly. When the valve is open the flow is unrestricted to the full capacity of the line. The valves are manufactured by the Nelson Valve Company, Wyndmoor, Philadelphia, Pa., in sizes suitable for use on pipes ranging from ⅜ to 3 inches in diameter.

A Fillet or Radius Gage.

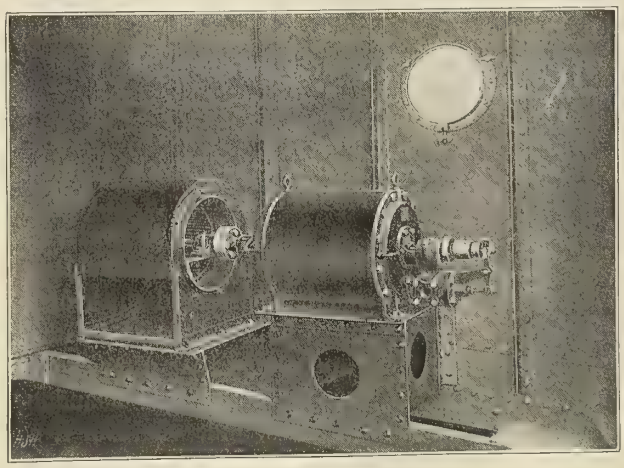
This gage, which is manufactured by the L. S. Starrett Company, Athol, Mass., is also referred to as a concave and convex gage and is especially adapted for use in laying out special forming tools, dies, etc., as well as for measuring fillets, making the tool of use to machinists and tool makers, as



well as pattern makers. The gage is made in two sizes, one with 26 leaves stamped to indicate radii by sixty-fourths from 1/16 inch to ¼ inch, and one with 32 leaves stamped to indicate radii by sixty-fourths from 17/64 inch to ½ inch. The illustrations show a few of the ways in which the gage may be used to advantage.

Sirocco Fans.

The distinguishing features of the Sirocco fan, manufactured by the American Blower Company, Detroit, Mich., are found in its blast wheel or runner. This is of drum form, with a large inlet chamber inclosed by numerous blades, which are very long axially but narrow and are curved forward. Instead of having from eight to sixteen blades it usually has sixty-four, and these blades are generally from six to nine



TURBINE-CONNECTED FAN.

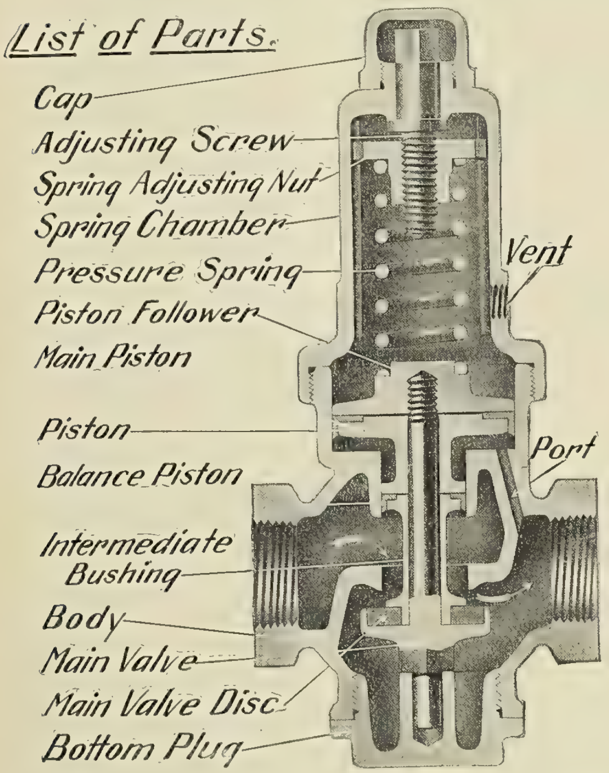
times as long as they are wide. This type of construction permits a given sized wheel at equal speeds to discharge a volume of air about four times as great as the old type of steel plate fan, or for a given duty it is claimed that the Sirocco fan can be made about one-half the diameter of the former standard paddle-wheel. By comparison with the former type the Sirocco fan occupies about one-half the space, saves one-third the weight and about one-fifth of the power. These advantages are very important when the fan is applied to marine work, but by no means the least important advantage is the fact that the fan does its work with very little noise, adding greatly to the comfort of passengers on board ship. The fans are made with either single-inlet runners or double-inlet runners, and may be driven by direct-connected reciprocating en-

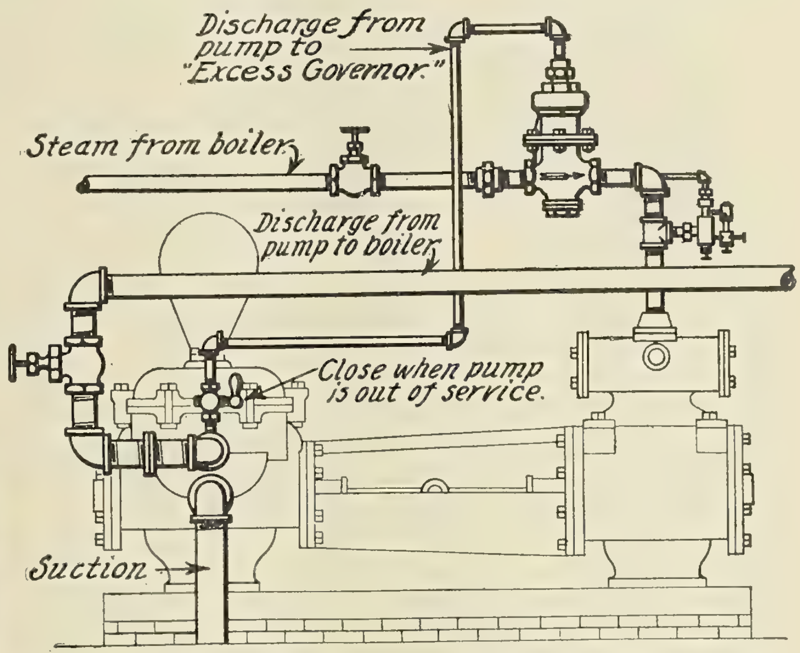
gines, electric motors or steam turbines. The increasing use of small steam turbines for driving the auxiliaries on board ship makes this type of installation perhaps of most interest. The illustration shows a 20-inch double-inlet fan, direct connected to a steam turbine for forced draft installation. The blower has a capacity of 28,000 cubic feet against a pressure of 5½ inches of water at 1,500 revolutions per minute. Forty-brake horsepower are required to drive the fan and an efficiency of 65 percent is claimed.

An Improved Method of Governing Pumps.

Most pump governors are designed to maintain the water discharge pressure at a certain fixed point, but there are numerous conditions under which this uniform discharge pressure is not altogether desirable—as in feeding boilers where the boiler pressure may vary. The disadvantage of a uniform high-feed pressure is readily evident on marine boilers where, say, 250 pounds pressure is carried at sea and perhaps only 80 pounds while in port. In these instances, unless the governors were frequently readjusted, pumps equipped with ordinary governors, would at all times tend to keep the feed-line pressure over 250 pounds. The enormous surplus pressure on the feed line when the boilers were running on the lower pressures would tend to throw the feed water into the boiler with great force, would grind out the valves quicker, would make accurate feeding difficult, and the pumps would race whenever the feed valves were opened. The fireman or water tender must also manipulate the throttle valve oftener, if there were no feed-water controllers on the boilers. It would thus be difficult to maintain the correct water-level in the boilers and, in addition to being noisy, the pumps would wear unduly. In cases like this it would be highly desirable if the governor maintained the feed-line pressure at just the right excess at all times to make the flow into the boiler regular.

The Foster excess pump governor, manufactured by the Foster Engineering Company, Newark, N. J., automatically maintains a fixed excess discharge pressure above the boiler pressure regardless of the amount of water being supplied. Referring to the cross section, it will be seen that the governor is provided with two diaphragms, the upper one subjected to the pump discharge pressure through the connection at the top of the governor, while the lower diaphragm is in communication with the boiler pressure. Between these two diaphragms is a differential washer, the proportions of which determine the excess of water pressure over the boiler pressure. Reducing the area of the upper surface of this differential washer will increase the excess discharge pressure and vice versa. Steam entering the valve passes through the port to the boiler under the lower diaphragm. This tends to raise the diaphragm and allow the upper spring to lift the auxiliary valve off its seat and permit steam to enter the piston chamber, thus forcing down the piston and main valve with which it is engaged and allowing more steam to pass to the pump. When the pump discharge pressure passing through the connection in the top of the governor reaches its proportional excess it acts on the upper diaphragm, forcing it down and tending to close the auxiliary valve. The steam pressure on top of the piston is thereby reduced, permitting the lower spring to close or partially close the main valve and reduce the steam pressure to the pump. The operation is not intermittent but continuous, the pump automatically slowing down or speeding up as conditions require.





TECHNICAL PUBLICATIONS

Oil Motors. By G. Lieckfield. Size, 6¼ by 8¾ inches. Pages, 272. Figures, 306. London, 1908: Charles Griffin & Company, Ltd. Price, 15s. net ($4.50).

This book is a translation of the third edition of *Die Petroleum und Benzinmotorem,* which in Germany constitutes a handbook widely read by all persons interested in the construction or operation of stationary and automobile engines using liquid fuel. From a description of the liquid fuels available the author leads up to the construction of various types of engines with explanations of their various parts, the functions of the latter, and concludes with very complete notes on troubles which may occur with gas engines and the various means of rectifying them. A number of pages are devoted to a discussion of marine engines and recent motor boats, showing installations as large as 3,000 horsepower.

Since the same appellations are not used for oil fuels in different countries, it is necessary for the reader to note carefully how various oils are designated. In this book the

report of the fuels committee of the Motor Union of Great Britain and Ireland have been very closely followed, in the hope that by adopting recognized standards the meaning of the various appellations will be accurately interpreted.

Regarding the much disputed question of what petroleum really is the author sustains the theory that it is the result of a natural distillation of animal matter. The most that can be said in favor of this theory is that it is quite as justifiable as the theories which class petroleum as the result of decomposition of vegetable remains or as the result of natural reaction of gases upon minerals.

The Economy Factor in Steam Power Plants. By George W. Hawkins. Size, 6 by 9 inches. Pages, 133. Figures, 49. New York, 1908: Hill Publishing Company. Price, $2.

The problems of power plant efficiency and economy are among the most important which must be met by the engineering profession. The possibility of a future scarcity of fuel and the certainty of increasing fuel costs lend additional weight to the subject. Moreover, the subject is one on which too often the designer is placed upon his own resources, so that he can obtain little information outside of what he has collected during his own experience as an engineer. In fact, there has been a tendency for individual members of the profession to jealously guard such information as part of their most valuable assets. Perhaps this feeling accounts for the fact that up to the present time little has been published treating comprehensively of this subject. The data used in compiling the work under review have been carefully selected from the results of actual experiments, all unauthentic reports and manufacturers' claims being absolutely discarded. One can be reasonably certain, therefore, that he has before him an authentic collection of data upon the economic performance of various pieces of apparatus which are used in a marine steam power plant.

The book is divided into four parts, the first taking up individual apparatus, such as boilers, engines, electrical generators, condensing apparatus, feed pumps, oil pumps, oil burners, feed-water heaters and fuel economizers. Part II. discusses the factor of evaporation, showing its effect upon complete plant economy and also the influence of the various auxiliaries upon it. In Parts III. and IV. the complete plant economy is considered, the full rated load being taken up in Part III. and the variable load in Part IV. Although it was the original intention to make the work apply only to oil-burning plants, yet the necessary conversion charts have been added, so that the results may be readily converted from oil to coal or wood, as desired. The part of the book relating to boiler efficiencies refers primarily to oil-burning practice.

The Gas Engine. By Forrest R. Jones. Size, 6 by 9 inches. Pages, 447. Figures, 142. New York, 1909: John Wiley & Sons. Price, $4.

The general order in which the subject is treated in this book is descriptive, operative, testing for faults, theoretical and results of trials. The descriptive portion is particularly well illustrated, many details being given which usually are shown only in the assembled engine. In connection with the operation of gas engines, illustrations are given of actual plants, and especial features of each are given in detail, showing not only the methods of starting and cooling, but also the method of regulating or governing the speed of the engine.

The part of the book describing tests is thoroughly practical, and will be of particular interest to operating engineers who may not have the advantage of theoretical training. Numerous examples of indicator cards, taken in actual practice, are given, and the calculations for finding horsepower are shown in detail. Considerable space is devoted to a description of producer gas apparatus and the fuels which are used for gas making. In this connection economy and efficiency are carefully considered.

The last part of the book is taken up with the theoretical discussion of various heat cycles and pressure-volume diagrams, while the results of the more important tests made by the United States Geological Survey are tabulated, showing the approximate analysis of various coals, the composition of producer gases from various fuels, and finally the number of pounds of coal per brake-horsepower delivered by the engine.

General Lectures on Electrical Engineering. By Charles Proteus Steinmetz, A. M., Ph. D. Size, 6 by 9 inches. Pages, 284. Figures, 48. Schenectady, N. Y., 1908: Robson & Adee. Price, $2.

These lectures, seventeen in number, are general in nature, dealing with the problems of generation, control, transmission, distribution and utilization of electric energy; that is, with the operation of electric systems, of apparatus under normal and abnormal conditions, and with the design of such systems, although the design of apparatus is discussed only so far as necessary to explain its operation and so judge of the proper field for its application. Due to the limitations of time and space, the treatment of such involved subjects must necessarily be essentially descriptive and not mathematical. That is, it comprises a discussion of the different methods of application of electric energy, the means and apparatus available, the different methods of carrying out the purpose and the relative advantages and disadvantages of the different methods and apparatus which determine their choice.

COMMUNICATION.

The Fastest Ships in the World.

Editor International Marine Engineering:

Supplementing your interesting article on the fastest ships (February, 1909) I should like to point out the extremely high value of $\frac{V}{\sqrt{L}}$ for motor boats. I have no reliable figures but I believe the following are fairly accurate:

	Length.	K. Speed.	$\frac{V}{\sqrt{L}}$
Hutton II	39' 9"	21.5	3.4
Legro-Hotchkiss	39' 3"	29.6	4.73
Napier II	40' 0"	25.0	3.95
Napier I	39' 9"	18.8	2.98
Quicksilver	30' 0"	18.2	3.32
Takumono	21' 4"	12.8	2.77
Britannia III	55' 0"	13.0	1.75
Wolseley-Siddeley	39' 4"	30.4	4.85
Wolseley-Siddeley*	39' 4"	27.35	4.43
Dixie II*	39' 6"	31.347	4.94
Dixie II	39' 6"	27.75	4.41
C. G. Patrol	75' 0"	12.5	1.44
Dragonfly	40' 0"	18.0	2.85
Oriole	40' 0"	21.2	3.35
Irene	39' 8½"	25.725	4.08

* In race.

It will be seen that, in calm water, these boats are very fast relative to their length.

E. M. Dixon.

The type of ferry described on page 29 of our January issue, which is in use at Finnieston in Glasgow harbor, was invented, patented and first constructed by William Simons & Company, Renfrew, for this particular service. The first boat of this type to be constructed was the *Finnieston,* 80 feet long, 43 feet beam, 9½ feet full-load draft. She was built by Messrs. Simons & Company in 1890, and has proved so valuable for this service that the additional boat described in our January issue has recently been built by Ferguson Bros., Port-Glasgow, for the same service.

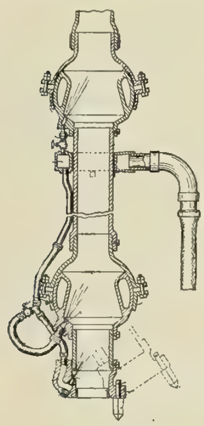
SELECTED MARINE PATENTS.

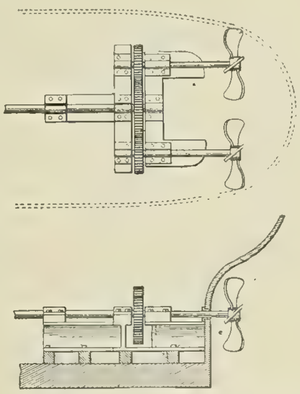
The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

910,277. APPARATUS FOR ELEVATING GOLD-BEARING DEPOSITS FROM RIVER BEDS. ALBERT LEE ELIEL, OF SAN FRANCISCO, CAL., AND OSCAR H. ELIEL, OF LA SALLE, ILL., ASSIGNORS OF ONE-THIRD TO LEWIS E. AUBURY, OF SAN FRANCISCO.

Claim 4.—An open-ended, vertically-arranged, hollow shaft, an air box mounted on the hollow shaft at the upper end, air tubes communi-





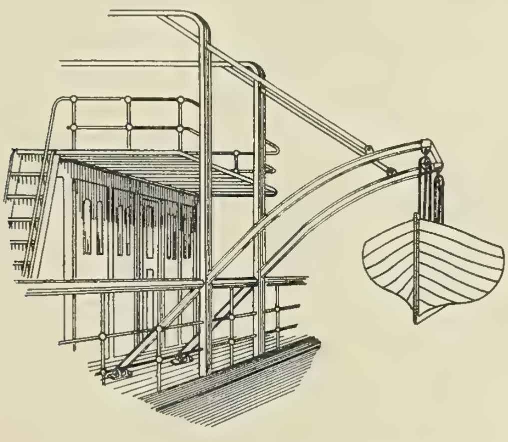
cating with the air box and with the lower end of the hollow shaft and a flexible tube communicating with the air box and with a source of compressed air. Twenty-seven claims.

910,439. WAVE POWER. LEWIS WOLFLEY, OF PRESCOTT,

Claim 3.—In a wave power, the combination with piers arranged to provide inlets therebetween, of a float reciprocally mounted within an inlet, an anchor beam extending across said inlet and sliding in channels in said piers, guides upon said float engaging said anchor beam, guide rods slidingly connecting said float and anchor beam and preventing lateral movement of the former, and power-transmitting devices operated by said float. Seventeen claims.

910,594. APPARATUS FOR LOWERING SHIPS' BOATS. CHRISTEN SMITH, OF SLEMDAL, NEAR CHRISTIANIA, NORWAY.

Abstract.—The boat rests on chocks which can be quickly removed by means of a system of tackles or similar appliances; the boat then hangs freely in a frame-like contrivance which is capable of turning in a vertical plane on pivots placed considerably lower than the boat and in-



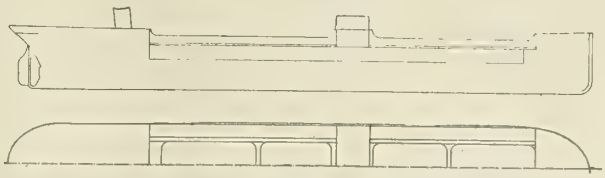
side its point of suspension. This suspension frame is kept in position by a system of tackles controlled from the boat, and these tackles have only to be eased off in order that the boat may be brought away from the side of the vessel ready to be lowered into the water. To the suspension frame are attached bars whose other ends are arranged to be movable in a transverse direction, being at the same time connected with ratchet and pawl arrangements to prevent any inward movement. By this means the rolling of the ship will not cause the suspension frame to turn inwardly while being lowered. One claim.

912,198. PROPELLING MECHANISM FOR BOATS. JAMES T. STAFFORD, OF NEW YORK, N. Y.

Claim.—A boat comprising a T-shaped structure consisting of a transversely disposed member and a forwardly extending longitudinally disposed member, a U-shaped structure consisting of a transversely disposed member and rearwardly extending longitudinally disposed members, bearings secured to the transversely disposed member of the T-shaped structure and to the longitudinally disposed members of the U-shaped structure, shafts journaled in the bearings, propeller wheels secured to the shafts, pinions secured to the saafts and disposed between the transversely disposed members of the structure, bearings secured to the transversely disposed members of the structure and to the longitudinally disposed members of the T-shaped structure, a shaft journaled in the bearings and a pinion mounted on the shaft and meshing with the first-named pinions, said last-named pinion being also arranged between the transversely disposed members of the structure. One claim.

911,581. CARGO VESSEL. JOHN ROBERT FROST DETTMER, OF SUNDERLAND, ENGLAND.

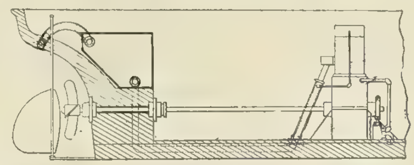
Claim.—In ships the combination of a hull, tanks of uniform section throughout disposed thereon continuously from the poop to the after end of the forecastle, top plates to said tanks carried inwardly to meet



the shell plating of the vessel below the joints between said plating and the hatchway coaming, and outer sides to said tanks which are set back from alinement with the sides of the vessel. One claim.

911,670. ENGINE. WILLIAM H. McLEOD, OF BOSTON, MASS.

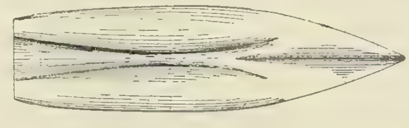
Claim 1.—A launch, having, in combination, a hydro-carbon motor, a



well communicating with the water outside of the launch, and an exhaust pipe for the motor passing through the well. Four claims.

911,806. BOAT. NAPOLEON B. BROWARD, OF TALLAHASSEE, FLA.

Claim.—A water craft, the bottom of which is formed of two rounded symmetrical and parallel after parts forming an intermediate channel, and a single forward part, the two after parts at the bottom partially



lapping upon the single forward part, but at a distance laterally therefrom, with channels between the overlapping parts formed by the shape of the bottom itself, and leading from the sides of the bow to the central channel. One claim.

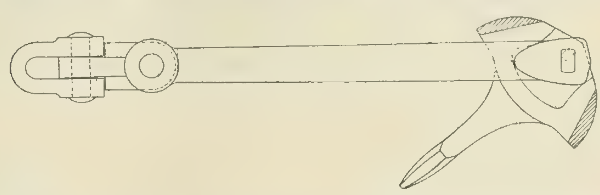
912,814. HYDROPLANE VESSEL. GEORGE RONSTROM CLIFFORD, OF CHICAGO, ILL.

Claim 1.—A hydroplane vessel, the entire bottom of which inclines backwardly and downwardly and forms the hydroplane, having a

pointed prow, a transversely rounded hull and a rearward, vertically tapering main body extension of considerable length, extending below the water line, the undersurface of which extension forms a continuation of the vessel's bottom. Six claims.

913,367. ANCHOR. THOMAS DOWNIE, OF LIVERPOOL, ENGLAND.

Claim 1.—In ships' anchors, a head having a passage therethrough and chambers in the side walls of the passage, the front walls of said chambers being curved, a shank provided with projections relatively



smaller than the said chambers, and so shaped that the opposite edges of each projection engage with the corresponding edges of each chamber when the shank is in its extreme positions, and the front edge of each projection bears against the curved front edge of each chamber. Two claims.

913,787. SUBMERGED FEATHERING PADDLE-WHEEL. LADISLAV VOJACEK, OF PRAGUE, AUSTRIA-HUNGARY.

Claim 2.—The combination of a stationary casing, a rotary inclosed casing arranged below the stationary casing, a hollow shaft penetrating the stationary casing and carrying the rotary casing, bevel gearing, inclosed in the stationary casing, for rotating said shaft and the rotary casing, a plurality of blades or paddles journaled in the rotary casing, a central gear inclosed by the rotary casing, other gears inclosed by said rotary casing and connecting the blades or paddles with the central gear, a shaft carrying said central gear and penetrating the hollow shaft and means for rotating said last-named shaft. Four claims.

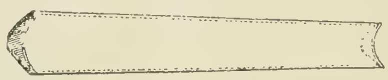
British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

20,672. TORPEDO ENGINES. WHITEHEAD TORPEDO WORKS AND E. LEES, WEYMOUTH.
In multicylinder torpedo engines of the single-acting, enclosed type the working parts are kept cool and free from deposit by directing the exhaust through water-cooled passages outside the crank chamber, and then delivering it to the hollow tail shaft at the rear side of a valved partition therein. In the four-cylinder engine shown, the exhaust from one pair of adjacent cylinders passes from the valve chambers, along corresponding pipes leading to a common conduit on the outside of the crank chamber. The first conduit leads to a second conduit communicating by peripheral holes with the hollow tail shaft on the side of the partition remote from the crank chamber. The water jacketing of the passages is in this case effected by allowing the sea water free access to the exterior of the crank casing. If found desirable, these passages may be formed by separate pipes instead of being integral with the crank and tail shaft casings. A valve in the partition automatically relieves any excess pressure in the crank casing due to leakage of fluid past the pistons.

21,122. TORPEDOES. G. F. JAUBERT, PARIS.
A heating device for the compressed air of torpedo engines consists of a number of cartridges with metallic or refractory envelopes and with tubular passages placed within a casing through which the air is arranged to pass. There may be insulating packing. The cartridges contain chemical fuels, and are fired simultaneously by means of a striker released by the same means which release the operating lever for the compressed air. The products of combustion do not mix with the air. The prior use is admitted of liquid-fuel burners, of incandescent thermite in contact with the current of air, and of a combustible material within tubes around which carbonic acid gas for actuating the engine passes.

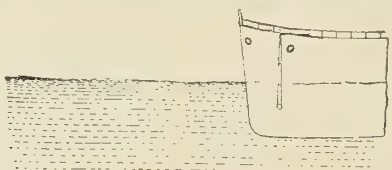
21,195. SHIPS' HULLS. C. A. MANKER, PEARL, ILL., U. S. A.
The under surface is of greatest width at the point of first contact with the water, and then curves upwardly towards the bow, the submerged portion inclining rearwardly and inwardly towards the stern. Stability guards are provided, but are carried round the stern to form a counter, which becomes slightly submerged when the vessel is under way, due to the lifting of the bow, consequent upon the under-water form of the vessel.

21,649. TURBINES. J. S. GREEN, PITTSBURG, PA., U. S. A.
Vanes and guide-blades of elastic-fluid turbines are made with a core of stiff, resilient metal, such as steel, and are covered with an envelope of non-corrodible metal, such as copper. The envelope is attached to the



core by welding. The method preferably employed is to weld an envelope to a mild steel or iron ingot. The whole is then worked as an integral mass, and is eventually drawn into strips of the desired blade section and cut into proper lengths.

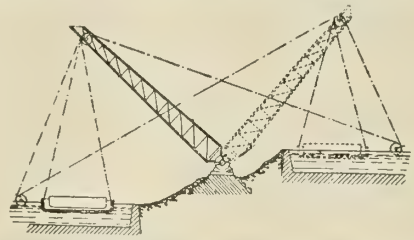
21,723. MARINE SIGNALS. L. DION, WILKESBARRE, PA., U. S. A.
A channel or ships' course is marked out at night-time and in foggy weather by a number of submerged incandescent electric lamps provided with reflectors for producing strongly illuminated patches of water, which may be close enough together to form a continuous bright track. Each lamp is buoyed at the end of a branch cable by a float, which may be constructed with the upper surface formed as a concave reflector. The bulbs of the lamps may be made thicker than usual and may be protected by cages. Different courses, such as the outward and return courses of a ferry, may be indicated by different-colored lights, and the light may be made intermittent by having an interrupter in circuit, or by switching the current alternately into two cables. In foggy



weather the lights may be observed through a water telescope or through a submerged bull's-eye in the ship's bows. The invention is specially applicable in the navigation of submarine vessels, and in time of war for indicating to friendly vessels by means of a series of lights a safe course of entry into a harbor defended by mines, the location of the neighboring mines being indicated by lights of different color, and the current being switched off as soon as the vessel is past the danger zone. The invention is also applicable for indicating the position of sunken rocks or shoals.

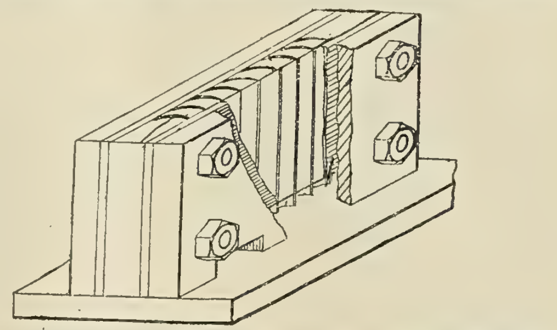
21,884. SCREW PROPELLERS. J. C. WALKER, GLAMORGANSHIRE.
Relates to screw propellers of the type in which the blades are secured to a circumferential ring provided with intermediate blades extending inwards, and consists in making the outer blades of an area equal to the area of the main blades less their ineffective root portion. The outer blades are at least half the length of the inner blades. The inner blades are preferably made to extend aft away from the boss, and the outer blades are arranged to extend forward from the surrounding ring. The nut by which the propeller is secured to the shaft is provided with blades.

21,731. SHIP LIFTS. B. SALOMON, FRANKFORT-ON-THE-MAIN, GERMANY.
In a canal ship lift, the lifting apparatus is constructed with a member or members capable of being swung about an horizontal axis and held in position by pulling ropes or chains extending on both sides of the axis and passing over drums. The carrier is attached by ropes directly



to the members, or to a lifting appliance mounted either on the members or in the vicinity of the axis by which the carrier can be raised and lowered independently of the movement of the member. In a modification, similar to a shear, the ropes are replaced by a rigid tension or compression member having a lower bearing capable of horizontal movement.

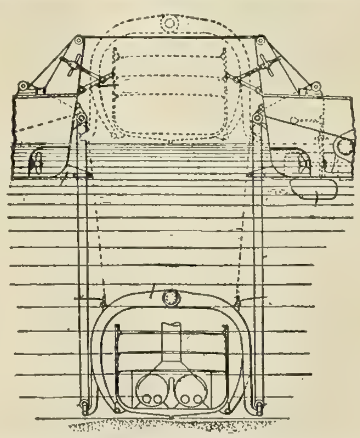
21,756. TURBINES. W. McKELVEY, J. McKELVEY AND R. KING, BELFAST, IRELAND.
A number of blades are combined with a segmental base-block for insertion in a rotor or stator groove, by arranging them in a mold and running in molten brass or other metal round the ends. The blades are notched at the end or are perforated to increase the strength. Other forms of notch may be used, or the blades may be cut and deformed at the ends. The figure shows the metal molding box or chill in which the base-blocks are cast upon the ends. It consists of a base, side plates and end pieces secured together, a gate being left for the introduction of the metal. The blades are separated by distance pieces, and a screw is fitted at one end to tighten them up in the mold. To allow



for the extra width of the base over the blades, plates of depth equal to the depth of the distance pieces are inserted, or the side plates may be stepped at the bottom. The segment is bent to the curvature of the rotor or casing and caulked into a dovetailed rotor or casing groove. The segments are locked together by a dovetailed joint or by some equivalent arrangement. The curvature may be imparted during the formation of the segment, and to facilitate insertion in the grooves a portion of one side of each groove may be removed, the last segment to be inserted being provided with a projection corresponding to the missing portion. The last segment is secured in place by screws or other means.

21,959. STEAM PUMPS. J. HUTCHINGS, LONDON.
A portable direct double-acting pump, for use in mines, ships, etc., is provided with an oscillating plug valve which controls the motive fluid to the power cylinder and the suction and discharge of the pump cylinder. The valve is provided with U-shaped divisional walls connecting the solid parts. On the completion of the stroke, the valve is oscillated by levers actuated by a tappet rod, which is connected to the piston-rod.

22,287. RAISING SUNKEN SHIPS. G. PINO, GENOA, ITALY.
In apparatus for raising submerged vessels, pairs of bowed gripping levers having clutch blocks to hold the vessel and lower tackle blocks attached at the alternate ends, are kept open during lowering by ropes



attached at intermediate points on the levers. The weight of the levers is partly balanced by cork, etc., filling. The lifting lines pass between adjustable guides; supports and ropes assist in holding the vessel when raised. The pontoons have rudders, which can be raised if required.

International Marine Engineering

JUNE, 1909.

THE JAPANESE VOLUNTEER STEAMER SAKURA MARU.

The *Sakura Maru,* which was recently completed and is at present on a cruising tour, is unique in many respects, for she is not only the first steamer for the Japanese volunteer fleet, but also the first which is fitted with turbine machinery constructed in Japan. It may be stated here that the Imperial Marine Association, which was founded in 1899, to deal with general maritime affairs, under the patronage of H. I. H. Admiral Prince Arisugawa, saw, during the Russo-Japanese war, the want of merchant vessels which could be fitted out as auxiliary cruisers, and sought the general sympathy of the public to assist the government in providing such vessels. As a result the Imperial Volunteer Fleet was founded in 1905, strongly supported by the general public, and also by material assistance from Baron Goto, minister of the Communication Department, then the Viceroy of Formosa. The Formosa Vicegerency promised to grant a yearly subsidy of £26,000 ($126,529), on the condition that the first steamer built should run between the mainland and Formosa, and in this connection more than half the fund for the first steamer was raised among the Formosans.

The order for first steamer was placed at the Mitsu-Bishi Dockyard & Engine Works in May, 1906. She was completed in October, 1908, and the management of the vessel was entrusted to Messrs. Osaka Shosen Kaisha, who are to run her as a mail and passenger express steamer between Kobe and Keelun, from the beginning of the year, under the auspices of the Formosan Vicegerency. The general particulars of the vessel are as follows:

Length between perpendiculars	335 ft.
Breadth	43 ft.
Depth	31 ft. 6 ins.
Gross tonnage	3,200 tons.
Draft	17 ft.
Displacement	3,880 tons.
Indicated horsepower	8,500
Speed on trial	21 knots.
Machinery—Parsons marine turbines.	
Boilers—Miyabara watertube.	
Number of special first class passengers	4
Number of first class passengers	28
Number of second class passengers	42
Number of third class passengers	240

THE SAKURA MARU, FIRST STEAMER FOR THE JAPANESE VOLUNTEER FLEET.

She has a cut-water stem, elliptical stern, two pole masts, with a small signal yard on the fore mast, and two elliptical funnels. As she is a fast boat her lines are very fine, and with her graceful sheer she presents a very smart appearance.

She has been built to meet the requirements of the Japanese Shipbuilding Regulations, and in addition every care and precaution was taken in her construction and fittings to ensure her suitable for use as a merchant steamer in peace and an auxiliary cruiser in war. There are seven watertight bulkheads, which, together with watertight bunker bulkheads, subdivide the vessel into eleven compartments. The main drains are 9 inches in diameter. All the machinery is below the waterline, and watertight coal bunkers are located along the sides of the machinery space. The rudder, steering gear and all communication apparatus and gears are below the waterline. Prevention of fire is effected by dispensing with woodwork as much as possible, and having the main fire-service pipes all below the waterline, with an arrangement so that even if some of the branch pipes which are above the waterline should be destroyed by an enemy, the remaining ones, by means of valves, would probably be ample. Provision is also made to receive two 6-inch guns, six 12-pounders, two 20-inch searchlights, wireless telegraph, magazines, naval boats and many other necessaries in case of need. Bilge keels are fitted for about two-fifths of the length of the vessel amidships.

FIRST CLASS DINING SALOON.

GENERAL ARRANGEMENT.

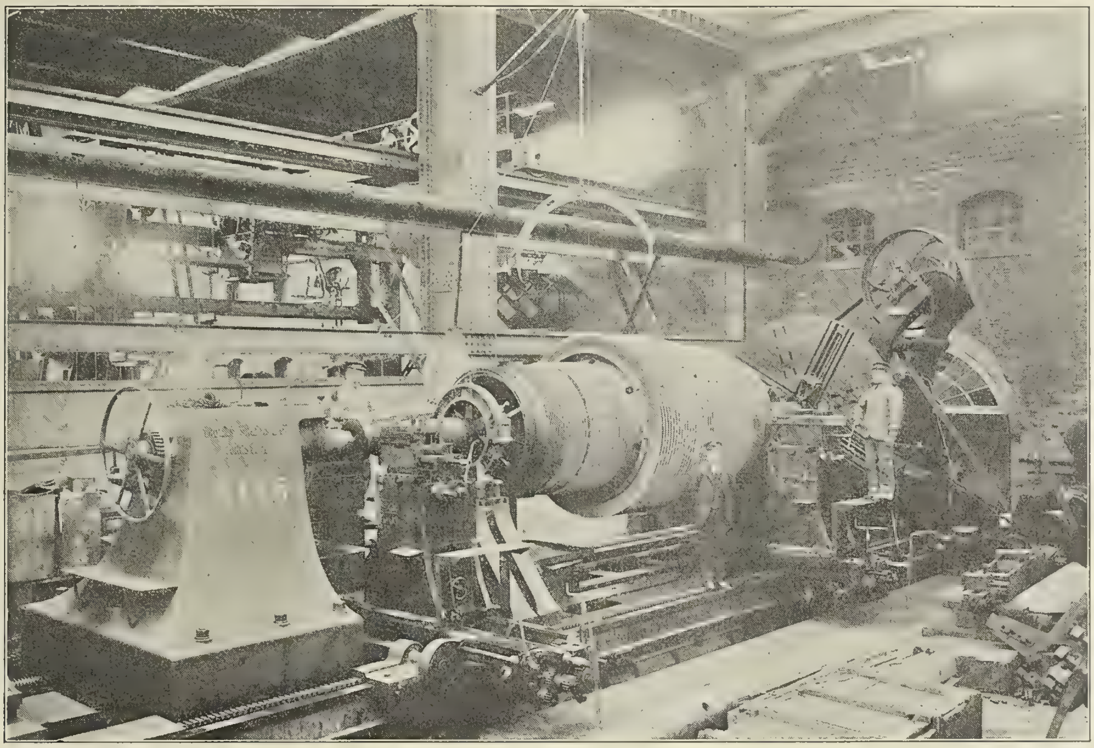
There are four decks—the boat, shelter, spar and main decks. The boat deck extends about 180 feet amidships, forming a splendid promenade for passengers. At the fore end of the boat deck there is a large deckhouse to accommodate the navigating officers, also with one special room for the special first class passengers. The roof of this deckhouse forms a spacious flying bridge, upon which have been placed the chart room, the bridge being used exclusively for navigating purposes. On the boat deck six 26-foot lifeboats are carried, four of which have Welin's patent quadrant davits. They are also fitted with shifting chocks, permitting the boats to be chocked either fully inboard or along the extreme edge of the deck, thereby saving promenade space. Other boats are fitted with extra heavy davits to receive the naval launches when required. Two other boats are stowed on the after boat deck on top of the after deckhouse. There is also a searchlight platform on the after boat deck.

At the forward end of the shelter deck there is a small deckhouse, which not only contains a companion way and lamp room but serves as a shelter for two cargo winches. About amidships there is a large deckhouse, containing the reading room, first class dining saloon, smoking room and several private cabins. At the center of this deckhouse there is an entrance hall leading to the dining saloon, with a grand staircase leading to the staterooms on the deck below. Ample natural light is provided in way of the staircase by means of a large skylight, decorated with stained glass. The sides and ceiling of the entrance hall are finished in the same manner as the dining saloon. On the central wall there is a large teak frame, with a bronze plaque, bearing over 600 names of the principal subscribers to the fleet.

In general the fittings and decorations of all the public rooms are neat and simple in character. The sides of the dining saloon are finished in a framing of teak, with oak panels inlaid with rosewood. The ceiling is of paneled pine, painted dull white. There is seating accommodation for thirty-four persons, arranged at small tables. There is a handsome sideboard of teak frame with oak panels with inlaid work. In addition to the light obtained from the side windows there are four skylights carried up to the flying bridge, thus conveying ample natural light to the saloon. Skylights and swinging doors are all decorated with stained glass. The upholstery is orange-red Japanese silk, giving the room a cozy and comfortable appearance. The floor is parquetted work of teak and oak. All metal work is of classic Japanese bronze.

Adjoining the saloon is the reading room, with walls and ceiling finished in a similar manner to the saloon but with upholstery of pale green, quite in contrast with the warm, orange-red of the saloon.

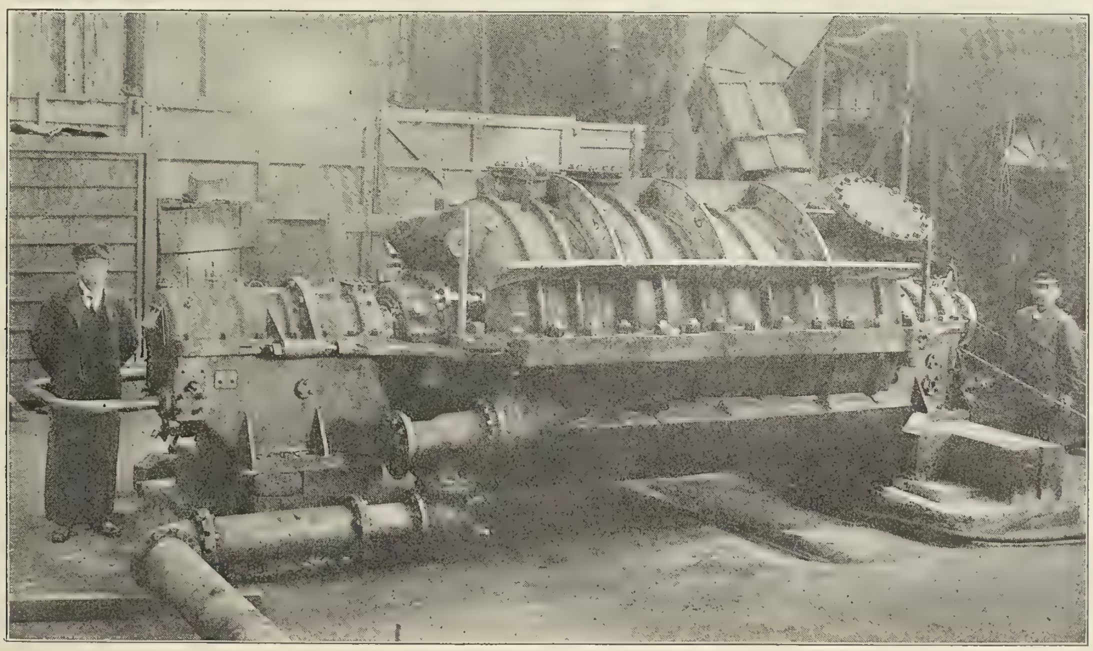
In the smoking room, the walls and ceiling are finished in a similar manner as the dining saloon, but the upholstery is of reddish-brown. The clerestory roof, with a skylight with stained glass on top, serves to add to the decorative effect



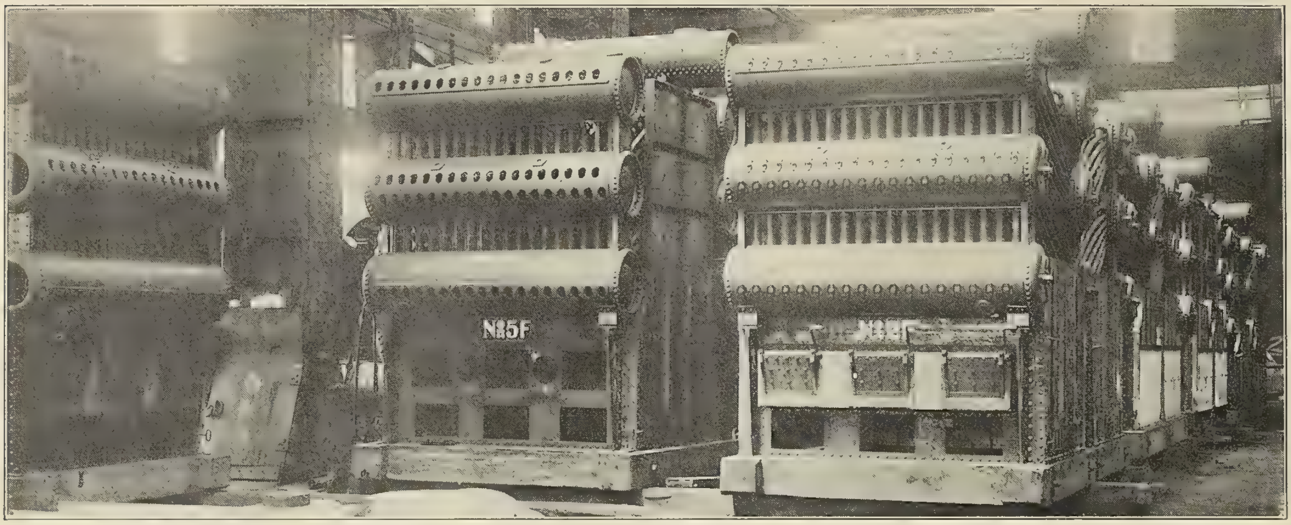
ONE OF THE TURBINE ROTORS, MOUNTED ON A LATHE IN THE BUILDER'S SHOPS.

as well as affording splendid light and ventilation. The floor is covered with inter-locking rubber tiles. At the extreme end of the house there is a barber shop. The remaining space in this deckhouse contains groups of staterooms with convenient baths, lavatories, pantry, bar, etc.

Forward of the engine casing there are commodious accommodations for the chief engineer, and at the after end an upper cold chamber has been provided with connection to one on the deck below, thus facilitating the shipping of provisions to the chambers. A large steel deckhouse is erected on the extreme after end, which is laid off at the fore end as a cargo winch house, with the hospital at the after end, and between these is placed the second class smoking room, with the second class entrance at the fore part. The walls of the smoking room are paneled with dark-colored oak, in bold designs of "rising sun" with carved capitals of cherry blossoms. The ceiling is of paneled pine, painted dull white. Natural overhead light is provided by the large skylights, decorated with stained glass. The upholstery is of yellowish-brown, and the floor is covered with linoleum.

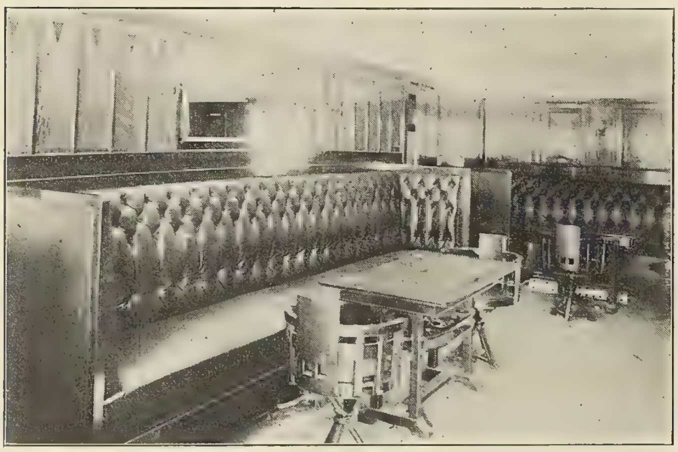


HIGH-PRESSURE TURBINE OF THE SAKURA MARU.



MIYABARA PATENT WATERTUBE BOILERS FOR THE SAKURA MARU.

The spar deck, from stem to stern, is covered, and may be designated the working deck. The petty officers' and third class passengers' accommodations are at the forward end. The extreme after end is devoted entirely to the second class passenger accommodations, with a roomy dining saloon in the center. This saloon, capable of seating twenty-eight persons, is a plain apartment with white-painted steel walls. Groups of cabins are arranged along the entire saloon, and passages. Forward of the grand staircase are eleven staterooms and well-equipped lavoratories. The center portion from the grand staircase aft is taken up with funnel hatches, turbine hatch, cargo hatch, saloon and native galleys; also a large space is devoted to the cold chamber. On the port side the firemen



FIRST CLASS SMOKING ROOM.

have their sleeping and sanitary accommodations; thus they can go about without coming into contact with the passengers. The special feature of this quarter is that the deck is entirely covered with Florbian composition, then laid with chequered steel plates, so that the deck could be kept exceptionally clean. On the starboard side ample accommodations have been provided for engineers, apprentices, cooks and stewards.

The dispensary is also on this deck, abreast the forward funnel casing at the after end of the first class accommodation and adjoining the doctor's room. Special care has been taken to select a spot free from vibration and noise for medical examination, and at the same time one convenient to the passenger accommodations. There is an engineers' mess room adjacent to the dispensary, the floor of which is cemented; thus it may be converted into a sick bay in case of necessity.

For about 145 feet amidships the main deck is given up for the entire breadth of the ship to the turbine room, boiler rooms, coal bunkers, work shop, dynamo and refrigerating machine room. Forward of these there are sailors' and third class stewards' quarters, also third class pantry, the remaining portion of the fore 'tween decks being used entirely for third class passengers. The aft 'tween deck is also fitted out for third class passengers in addition to the large space devoted to the mail rooms and store rooms.

A complete refrigerating plant, supplied by Messrs. J. Hall & Company, is fitted for the preservation of fresh provisions. The plant is capable of producing a large quantity of ice daily.

There is a complete installation of electric light, the power plant consisting of two sets of combined engines and dynamos, of the compound type, either one of which is capable of generating and supplying light equal to about 6,200 candle-power, and of supplying the necessary current for three cluster cargo lamps of 200 candle-power each, and all signal lamps, motors, fans, etc. The current is transmitted by insulated cable of high conductivity, all wiring being done on the double-wire distribution box system. The main switchboards are fitted with ammeters, voltmeter and switch, pilot lamps and switches, double-pole switches and fuses for each of the generators, and change-over switches and double-pole fuses for each of the main circuits. The instruments are of the moving-coil type, and the whole switchboard is arranged for easy handling.

Each compartment has an outlet and inlet ventilator, and these are placed at opposite ends, to produce a continuous current of air. In the third class accommodation the foul air is exhausted by means of powerful electric fans, through trunks led under the beams. Seventeen large overhead electric fans are distributed in the public rooms, and over forty small ball-socket portable fans in the first, second and third class accommodations.

The machinery for working the ship includes a steam windlass supplied by Messrs, Harfield & Company. On the after part of the vessel there is a steam warping capstan with horizontal engines, built by Messrs. Clarke, Chapman & Company. The cargo winches are of the builder's make. The steering gear is by Messrs. Caldwell & Company, the gear being fitted with both telemotor and controlling rods, the former led below the waterline and the latter through the superstructure, and so arranged that when one of them is deranged the other may be readily put into operation. The principal standard is on

the flying bridge, but there is a second standard on the after part of the boat deck, thus providing means of steering when the principal one is destroyed. The vessel is also provided with an auxiliary telemotor standard, which is to be fitted below the waterline when engaged in naval service. The engine-room telegraphs, steering and docking telegraphs, are supplied by Messrs. J. W. Ray & Company. The engine-room telegraphs are of two independent sets, one being the working and the other the stand-by. There are also Messrs. Chadburn & Son's direction tell-tale and revolution indicators on the flying bridge. In addition to the above the Graham's marine type loud-speaking telephone and speaking tubes, with connection to various important stations, complete the appliances for the transmission of orders from the bridge.

PROPELLING MACHINERY.

The turbine-propelling machinery is of the Parsons type, having the three-shaft arrangement, now usually adopted for merchant steamers, with one high-pressure turbine coupled to the center line of shafting, and one low-pressure ahead and an astern turbine incorporated in the same casing coupled to each wing shaft. Each line of shafting drives one solid Stone's manganese bronze propeller. The turbines of the *Sakura Maru* are the first set designed and manufactured by the builder since they obtained the right for manufacturing the Parsons turbines in Japan, Korea and China. The rotor-wheels are cast steel, the spindles of forged steel of special quality and the casings of cast iron. The blades are of hard drawn brass, and are fixed in the rotors and casings in accordance with Parsons' usual design. The adjusting blocks, which are incorporated in the turbines, are so constructed that they admit of being readily adjusted while the turbines are running. The handles of all starting and maneuvering valves for the ahead and astern turbines are accessible from the starting platform at the forward end of the engine room, and are operated entirely by hand, so that one engineer can have entire control of the whole machinery. With this arrangement the port or starboard turbine is capable of being worked ahead or astern independently of each other and of the high-pressure turbine, the latter rotating idly when maneuvering.

A governor, working in conjunction with a throttle valve, is fitted at the forward end of the turbine bearing. It is driven by worm gear from the rotor spindles. The governor on each shaft is arranged to act independently, and close the throttle valve in the event of the shaft breaking, or the speed of the turbines exceeding the limit at which the governors are set, owing to the propellers racing in a seaway.

Chadburn's patent tachometers and tell-tales are fitted to the forward end of each turbine, and are so arranged that the engineer on watch can, from the starting platform, see not only the direction of rotation of each shaft, but also the number of revolutions of each shaft.

The condensers, two in number, with steel plate shells, are placed in the wings of the ship; Parsons patent augmentor condenser is fitted to each condenser. Water is circulated through the condensers by two independent centrifugal pumps of the builder's make, and there are two sets of Messrs. Weir's twin air pumps of the latest type. Owing to the low temperature of the hot well, consequent upon the attainment of high vacuum, it is becoming more important to consider the economy which may be attained by utilizing the latent heat of the exhaust from the auxiliaries. With this end in view, a surface heater has been fitted, through which the feed water is circulated on its way to the boilers. The feed water is passed through a filter and is then delivered to the boilers by two pairs of Messrs. Weir's double-acting pumps. Each pair of these pumps is capable of supplying the boilers when the turbines are exerting their full power, and so connected that either pair may deal with turbines. Two of Weir's direct-acting pumps are fitted for supplying oil under pressure to the turbines, one for ordinary working and the other for stand-by purposes.

The boilers are arranged in two compartments, each of which has a separate funnel, and in each compartment there are fitted three Miyabara's patent watertube boilers. The boilers work under forced draft, of the closed stokehole system, air being supplied by two fans, each driven by an independent double-acting steam engine. There are two large elliptical funnels. The funnels are double, the spaces between the inner and outer funnels being utilized for ventilating the boiler rooms and stokeholes. The provision for the disposal of the ashes has been made by fitting in each boiler compartment one of See's ash ejectors. One special donkey pump is fitted for working the ejectors. For harbor duty two steam ash-hoisting engines are provided.

AUXILIARY MACHINERY.

The auxiliary machinery includes two large electric engines and dynamos, one of Hall's Company machines, pumps for sanitary purposes, for washing decks, for extinguishing fire and for fresh water for passengers' use. There are also bilge and ballast pumps. The distilling plant consists of two evaporators, together capable of producing from sea water 30 tons of fresh water per twenty-four hours, and two distilling condensers having a combined output of 2,240 gallons of pure, fresh drinking water per day. The engineers' workshop is fitted with a drilling machine, shaping machine, screw-cutting lath, grinder, etc., driven by an electric motor.

SPEED TRIALS.

The full speed trial of the *Sakura Maru* was run on Sept. 26, 1908, over the measured 3.458-nautical mile government course, the results of the six runs being as follows:

Runs.	Speed.
One (down)	21.171
Two (up)	21.390
Three (down)	21.280
Four (up)	21.538
Five (down)	21.316
Six (up)	21.688

It will be seen that the vessel attained a maximum speed of 21.688 knots, the mean of means of the six runs being 21.393 knots, while the guaranteed trial speed was 21 knots.

The construction of the vessel has been under the supervision of Captain-Constructor Dr. Sakurai and Dr. Shin, members of the constructive committee of the Imperial Volunteer Fleet.

TYPES OF WARSHIPS OMITTED IN RECENT PROGRAMMES OF NAVAL CONSTRUCTION.

BY THE RIGHT HON. LORD BRASSEY.

In considering programmes of construction, battleships stand first in order. Those now building for every maritime power are of the *Dreadnought* type. To the British Admiralty belongs the credit of producing the first specimen of the new class of battleship, showing a marked advance over all preceding types in speed and in guns of the heaviest calibre. The coal endurance is sufficient for ocean passages. Occasions may arise in naval warfare when superiority in speed and big-gun armament might decide the issue. It is necessary to secure a preponderance for the British navy in *Dreadnoughts*.

It is not inconsistent to contend that other types beside the *Dreadnought* are of great value for the line of battle. We

* From a paper read before the Institution of Naval Architects, March, 1909.

see in recent naval construction a continuous increase in dimension and in cost.

	Displacement. Tons.	Cost (Including Guns).
Lord Nelson........	16,500	£1,654,098 ($8,030,000)
Dreadnought	17,900	£1,813,100 ($8,809,000)
Téméraire	18,600	Not given in navy estimates.
St. Vincent..........	19,250	In round figures possibly
Neptune	20,000	£2,000,000 ($9,733,000).

The latest battleships designed for Germany, United States and Japan are ships of 20,000 tons.

In his recent volume on *Naval Administration,* Captain Mahan insists on the objections to continual increase of dimensions: "When a certain speed has been attained, a small increment must be purchased at a very great sacrifice. What shall the sacrifice be? Gun power? Then your vessel, when she has overtaken her otherwise equal enemy, will be inferior in offensive power. Armor? Then she will be more vulnerable. Something of the coal she would carry? But the expenditure of coal in ever-increasing ratio is a vital factor in your cherished speed. If you can give up none of these things, will you increase the size? * * * Will you have smaller numbers with larger individual power? Then you sacrifice power of combination."

There are considerations in connection with armaments. "The main instrument," says Sir Cyprian Bridge, "is the gun, and it is its fire that has to be concentrated. If the ships are distributed at suitable intervals, the enemy's return fire must be either divergent or be only imperfectly concentrated. * * * The mounting of very heavy armament in single ships reduces numbers. * * * This constitutes an obstacle to the desirable tactical dispersion." So, too, Sir Reginald Custance. In his chapter on the Battle of Tsushima, the gallant author shows how "the fire of sixty-three guns was concentrated on the leading ships of the Russian line. Shells rained on their decks. They were enveloped in a sheet of flame. The great principle of dispersing the guns to concentrate their fire was emphasized and confirmed."

With increase of dimensions we have not secured invulnerability. It is not possible to protect the whole area of side above water with impenetrable armor. In the war in the Far East the mine was a deadly weapon.

If we were creating a new navy for the defence of the British Empire, it would be desirable to lay down a proportion of ships of moderate dimensions. We are relieved of this necessity. We have, as Mr. McKenna has said, a mighty fleet of ships earlier than the *Dreadnought.* The forthcoming volume of the *Naval Annual* will give a list of forty-four British battleships. Classing the *Lord Nelsons* for the time being as *Dreadnoughts,* we have no less than thirty-eight other ships, of which the oldest was launched in 1894. Collectively, these ships carry 144 12-inch guns, eight 10-inch guns, thirty-two 9.2-inch guns, twenty-eight 7.5-inch guns and 428 6-inch quick-firers. They are heavily armored. Speed 18 to 20 knots. With brave and well-trained men behind the guns, and under the command of captains reared in a service which has no record of failure, we have a fleet of vessels which well answer in these later days to the two-deckers of the glorious past.

It is not necessary to dwell on the armored cruisers. The type has disappeared from the latest programmes of construction. Equal in dimensions and in cost, with a slight inferiority in armament and armor, but with a steaming power equal to 25 knots at sea, the four ships of the *Invincible* type and the *Indefatigable* should certainly be included in the *Dreadnought* class in any comparison of naval strength. Armored cruisers cost as much per ton as battleships. Our appropriations to cruiser construction have not been approached under any other naval administration. In the view of many naval authorities it would have been well to have spent less on armored cruisers and more on battleships.

The large protected cruisers are the least effective of all the ships on the British navy list. It is a waste of public money to keep such ships as the *Powerful* and *Terrible* in commission. They carry large crews. They are too vulnerable to be reckoned as fighting ships.

It remains to refer briefly to the inshore squadron. The *Dreadnoughts* are essentially ships for the open seas—beyond the range of the torpedo, and free from the danger of the floating mine. In narrow and shallow waters, in the southern part of the North Sea, with all lightships and buoys removed, navigation would be hazardous in the extreme. At night, and in thick weather, the torpedo would become a most formidable assailant. The gun is a useless weapon against an invisible foe. The naval experience and professional skill which have produced our noble fleets for the open waters should now be directed to the creation of a type specially designed for the inshore squadron.

We are strong in destroyers and submarine boats. The *Monitor,* the armored ram, as designed by Admiral Ammen, U. S. N., and the protected torpedo vessel, as exemplified in our own *Polyphemus,* are types of a past era, but which might still be found effective in modern warfare.

It is hardly possible to close without a reference to pending discussions of to-day. We must look to the future. We must add to the expenditure on construction. We are strong in ships. The amounts voted for Great Britain, Germany and the United States are approximately the same. In Germany one-half, in the United States one-third, in Great Britain one-fourth, of the amount voted for the navy is available for new construction. We cannot keep ahead without further effort.

MARINE PRODUCER GAS POWER.*

BY C. L. STRAUB.

The marine public, who since the days of the Clermont have exclusively associated the term "motive power" with "steam," have every reason for demanding exact and conclusive evidence of the superiority of gas power or any other power, before adopting it in lieu of their present methods. This evidence is only now slowly coming forth. Many who have been credited with authority by the engineering profession and others, either through ignorance or through being misinformed, have beset the way of marine gas power with numberless imaginary obstacles, ridiculous in proportion to the real difficulties, but sufficient, nevertheless, to instill some doubt of the possibilities of the system into the minds of the waiting public.

Only recently has such progress been made in the development of gas power for marine work as to warrant its early adoption in commercial service. Two years ago, less than 300 horsepower in the aggregate was being developed by marine producer gas power installations; these were experimental in nature, and were of the German Capitaine type. There are now installed and accepted twenty-three Capitaine marine plants, aggregating 2,035 horsepower, a partial list of which follows:

a Emil Capitaine, launch, 60 brake-horsepower; four-cylinder, single-acting, four-cycle engine; boat, 60 feet long, 10 feet beam, 4 feet deep; ran an average speed of 10 miles for ten hours on 412 pounds of anthracite coal.

b Rex, seagoing Swedish boat; 102 feet long, 22 feet beam, carries 350 tons on 9-foot draft; fitted with a three-cylinder, single-acting, 45-horsepower engine at 300 revolutions per minute.

* Read at the May, 1909, meeting of the American Society of Mechanical Engineers.

c Capitaine, towboat at Genoa; length, 47 feet; beam, 12 feet; draft, 7 feet; fitted with a three-cylinder, single-acting, four-cycle engine, 105 brake-horsepower at 240 revolutions per minute.

e Dusseldorf, tug at Hamburg; fitted with a four-cylinder, single-acting, four-cycle engine, 60 brake-horsepower at 240 revolutions per minute.

f Isee, tug; fitted with a three-cylinder, single-acting, four-cycle engine, 45 brake-horsepower, 300 revolutions per minute.

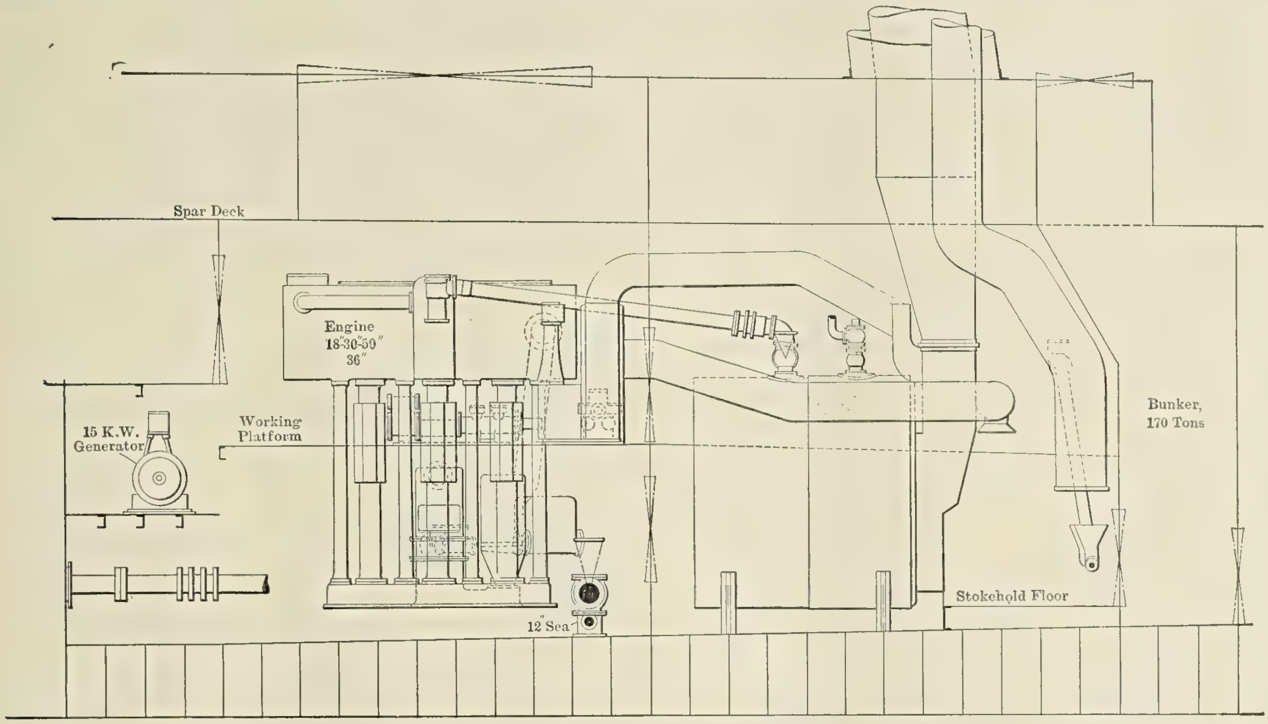


FIG. 1.—ELEVATION OF 1,000 HORSEPOWER STEAM POWER PLANT, NOW INSTALLED IN LAKE FREIGHTER.

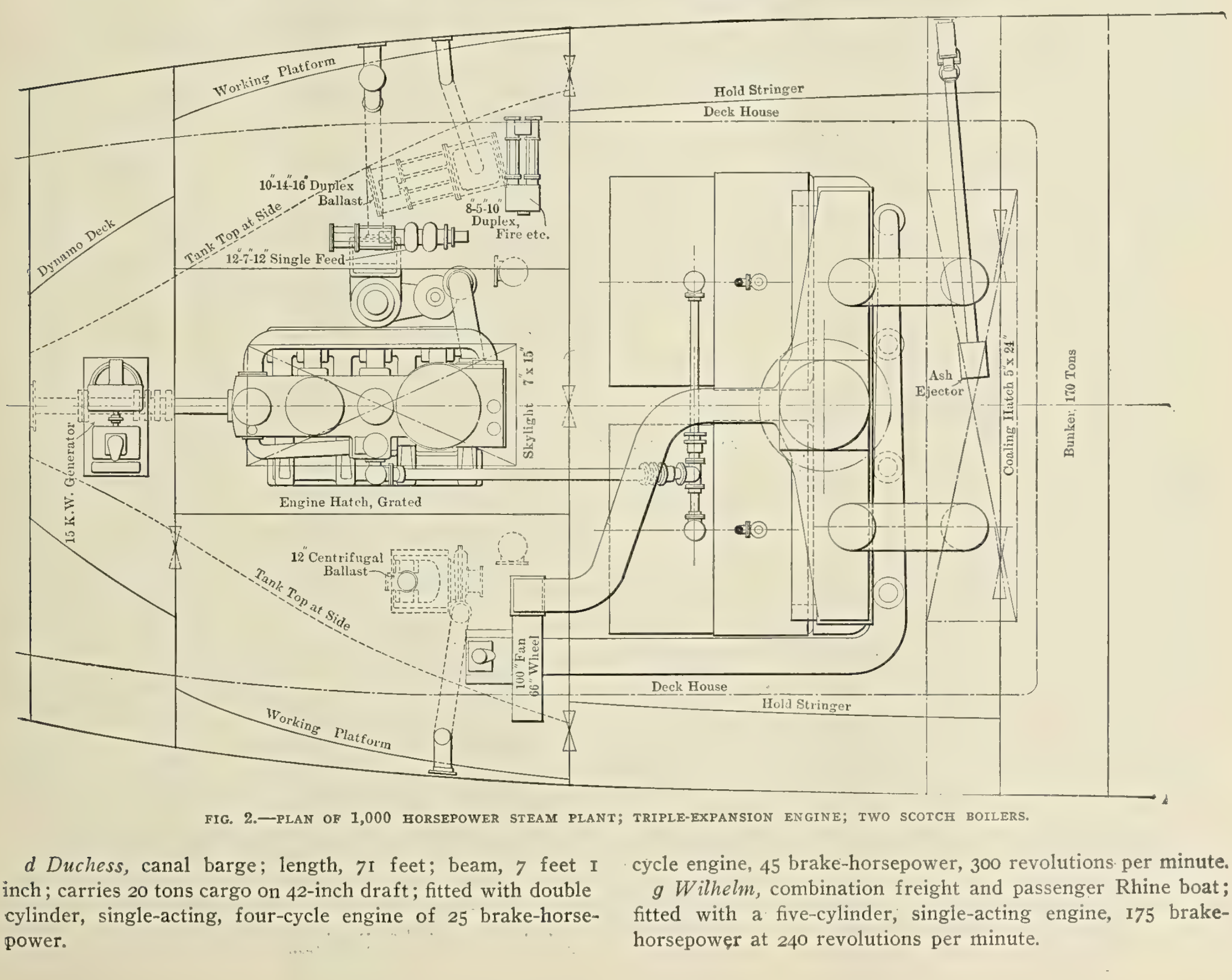


FIG. 2.—PLAN OF 1,000 HORSEPOWER STEAM PLANT; TRIPLE-EXPANSION ENGINE; TWO SCOTCH BOILERS.

d Duchess, canal barge; length, 71 feet; beam, 7 feet 1 inch; carries 20 tons cargo on 42-inch draft; fitted with double cylinder, single-acting, four-cycle engine of 25 brake-horsepower.

g Wilhelm, combination freight and passenger Rhine boat; fitted with a five-cylinder, single-acting engine, 175 brake-horsepower at 240 revolutions per minute.

h Badenia, Rhine freight boat; fitted with a two-cylinder, single-acting, four-cycle engine of 30 brake-horsepower.

i Katrina, canal freight boat; fitted with a three-cylidner, single-acting, four-cycle engine, 45 brake-horsepower.

j Marie, canal freight boat; fitted with a three-cylinder, single-acting, four-cycle engine, 45 brake-horsepower.

k Hoffnung, combination freight and passenger Rhine boat; fitted with a five-cylinder, single-acting, four-cycle engine of 210 brake-horsepower.

l Amersie, Volga freight boat; fitted with a four-cylinder, single-acting, four-cycle engine of 60 brake-horsepower.

m No. 58, canal freight boat; fitted with a four-cylinder, single-acting, four-cycle engine of 60 brake-horsepower.

In addition to the above there were a number of freight boats, the dimensions and names of which we were unable to obtain, but whose power plants varied in capacity from 30 to 175 horsepower each.

n H. M. S. *Rattler,* an old gunboat; 165 feet long, 29 feet beam, originally fitted with a triple-expansion engine. The gas engine is five-cylinder, single-acting, four-cycle. Cylinders, 20 inches diameter by 24-inch stroke, developing 500 brake-horsepower at 120 revolutions per minute. This engine is started by means of a mixture of gas and air, which is pumped into the cylinders at a pressure of about 95 pounds per square inch. This complete plant was designed entirely in the Capitaine Works at Düsseldorf. The total weight of the entire plant, including the donkey boiler for working the pumps and auxiliaries, is 94 tons, as compared with 150 tons in the case of the displaced steam engine. A consumption of 1,525 pounds of coal was made for a measured distance of 45 nautical miles, on an average speed of 10½ knots. The cost per mile for fuel with coal at 15s. 6d. per ton is $0.064. This boat made a maximum speed of 11.3 knots against a 1½-knot current at 110 revolutions per minute of the engine shaft.

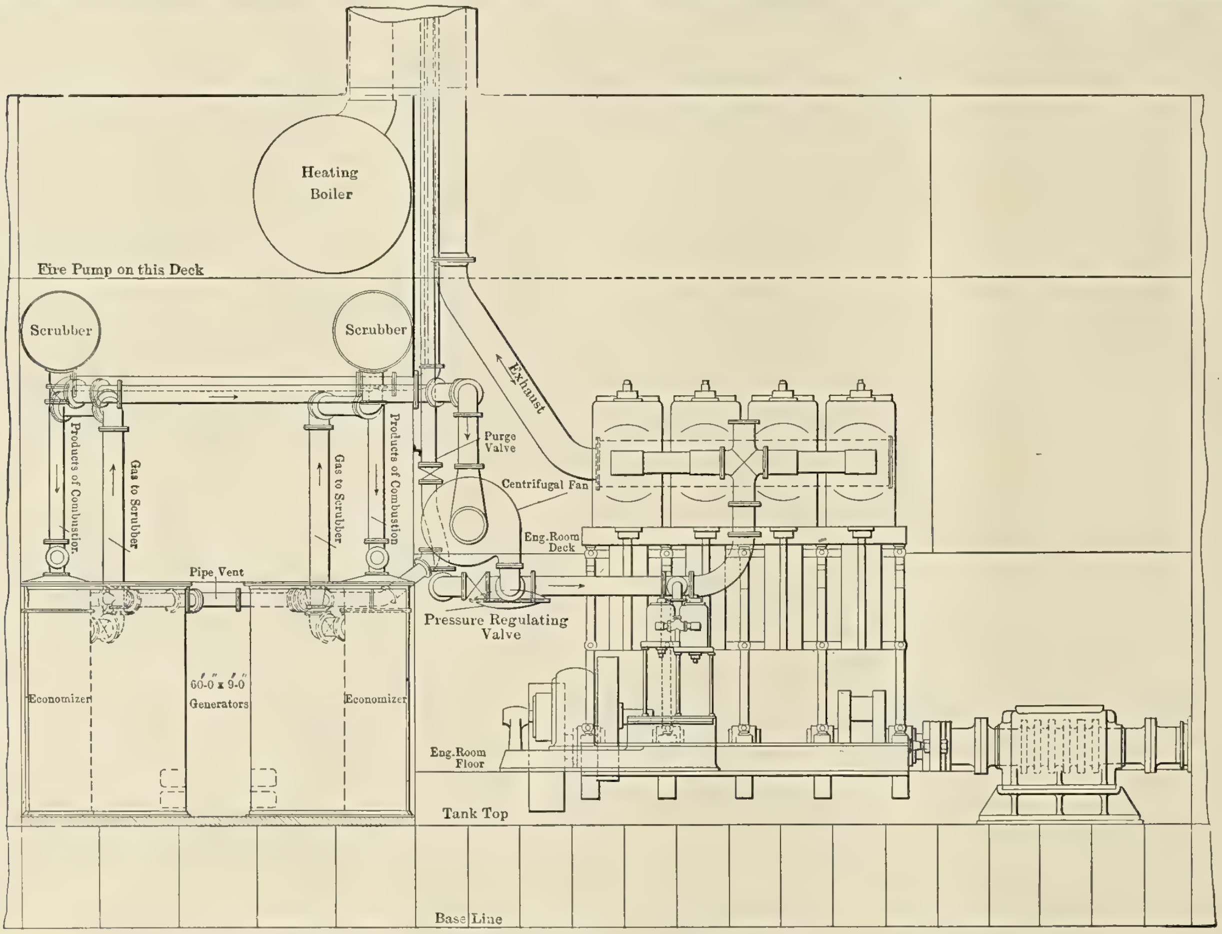


FIG. 3.—ELEVATION OF PROPOSED FOUR-GENERATOR MARINE PRODUCER GAS PLANT; 1,000 HORSEPOWER.

All of the above plants by their design and construction are restricted to operation on anthracite coal, coke or hard-burned charcoal, and any plant so restricted by its design to one class of fuel is seriously limited in its scope of application. The development of a simple marine gas producer for use with any class of solid fuel is a necessity, if the system is to be considered seriously by the marine profession. The writer is fortunate in having been associated with some recent American developments both in stationary and marine gas-power plants, a brief survey of a portion of which will enable us to draw more clearly the comparison between a typical steam and a possible gas installation. There are in commercial operation in this country to-day two distinct types of stationary power-gas producers which are suited by their design for operation on almost any class of solid fuel. They may, by their systems of operation, be qualified as up-draft and down-draft producers.

In the up-draft producer, the fuel is charged into the generator through an air-tight mechanism at the top, while air and steam, or air and products of combustion, are admitted at the bottom of the fuel bed, and passing upward, leave the generator at the top in contact with the fresh fuel. Almost all of the hydrocarbons leave the generator unfixed with the hot gas, only to be condensed later in the gas coolers or scrubbers and gas mains, forming large amounts of tar, which, if not removed to a minute degree, will positively prevent the operation of the engine. The removal of this tar is troublesome, and is accomplished at a loss of power and efficiency. The fuel in the upper zone of the bed in the up-draft producers cokes and cakes so seriously as to require continuous poking of the fuel bed, either mechanically or by hand. These features and others in this type of apparatus contribute to limit the rates of combustion per square foot of grate to a relatively low quantity. All things considered, therefore, this type

of apparatus has not lent itself agreeably to modification for marine service.

In the down-draft type of apparatus, the fuel is charged by hand through a large door at the top of the producer, which is normally in an open position, allowing the operator unrestricted inspection of the whole upper zone of the fuel bed. The hydrocarbons contained in the fuel are driven off in the upper zone, mixed with air and almost completely burned, and the burnt products, passing downward through the relatively deep bed of fuel, are decomposed and regenerated into carbon-monoxide and hydrogen gases. All of the tar and the lighter hydro-carbons are completely fixed in this process, and almost 100 percent greater than the average rating of the up-draft type of producers.

Undoubtedly a better method of measuring the ability or success of these two systems is to make note of the number and capacity of plants of each type in actual operation on engine service. A report of the committee on gas engines of the National Electric Light Association, spring of 1908, showed that in gas-engine power plants, of capacities of over 300 horsepower each, there were in operation thirty-two plants of both types having a total capacity of 57,225 horsepower. Of these, four plants were of the up-draft type, having an aggregate capacity of 4,050 horsepower, and twenty-eight plants

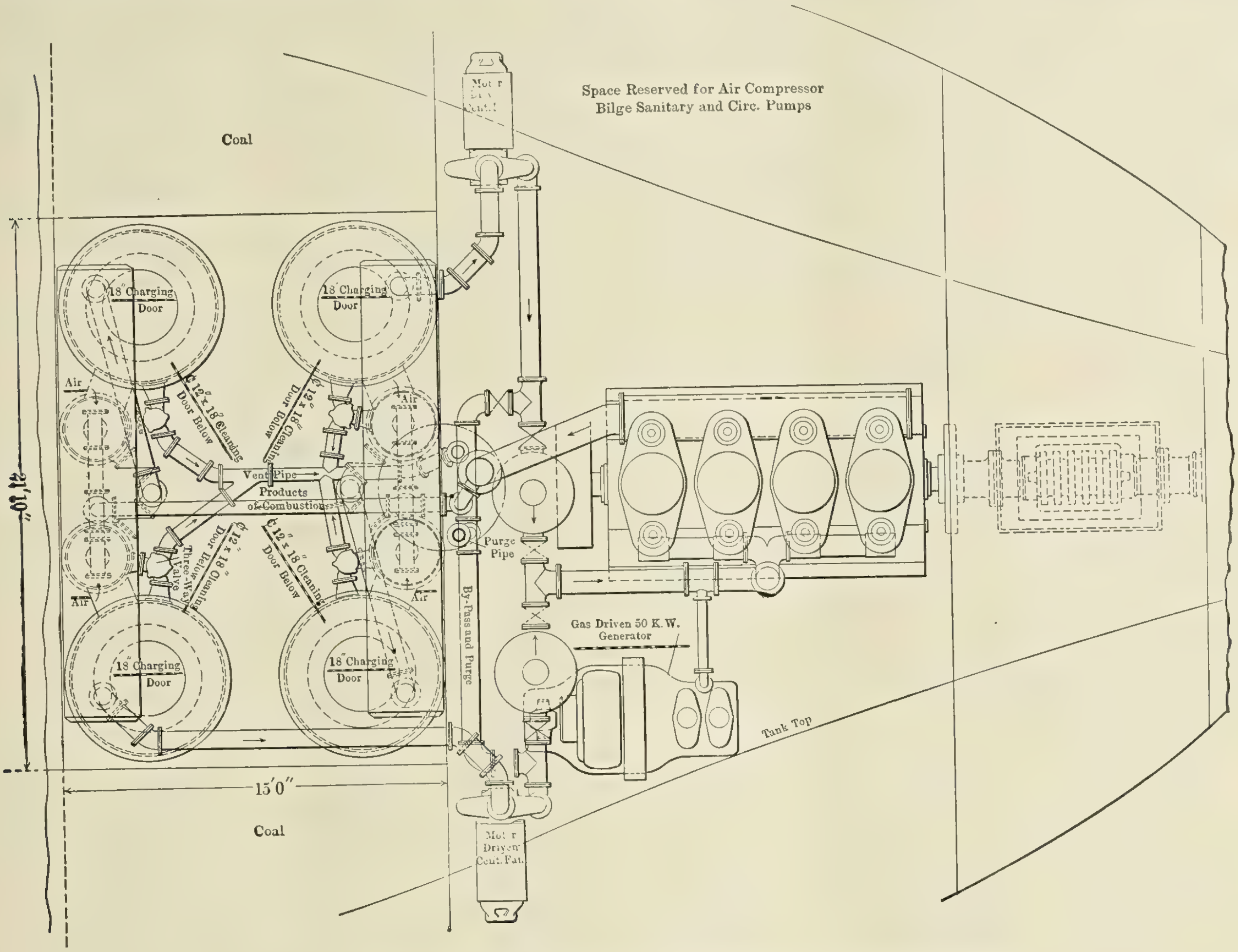


FIG. 4.—PLAN OF PROPOSED FOUR-GENERATOR MARINE PRODUCER GAS PLANT; 1,000 HORSEPOWER.

no tar is found in condensation in any portion of the plant after cooling. Coking or caking of the fuel bed is not detrimental, but, on the other hand, assists in keeping the fire in the open porous condition, which is desirable and necessary where high rates of combustion obtain. This feature eliminates the poking necessary in the up-draft apparatus. The gas leaves the bottom of the producer through brick-lined connections, and a portion of the sensible heat is extracted in passing through an economizer. The gas is then cooled and washed and passed through an exhausting mechanism, whence it is delivered under pressure to the engine.

This type of apparatus lends itself admirably to the high rate of fuel combustion, which for the sake of economy in space and weight is desirable in marine service. There are in actual commercial operation to-day a number of plants of this type having an average fuel consumption of over 40 pounds of good bituminous coal per square foot of grate per hour. These producers are sold on a rating of from 18 pounds to 20 pounds of fuel per square foot of grate per hour, which is were of the down-draft type, with an aggregate capacity of 53,175 horsepower. The latter contain the Loomis-Pettibone gas generating apparatus, some of which has been in operation on engine service for thirteen years.

Three years have been devoted to the modification of these stationary plants for marine service. The work involved a reduction in the size and weight of the generators; complete revision of the scrubbing, gas-cleansing and exhausting mechanism; elimination of all gas holders, storage receptacles, mixing chambers, etc. The plant as modified to date has a light, compact producer, which, while retaining the same rate of combustion as the stationary apparatus, has materially reduced dimensions and weight of the shell, brick lining, fittings, etc. The economizer boilers which were used on stationary work have been abandoned, and replaced with light air-heating economizers. The gas coolers no longer contain any coke or broken material, or wooden trays, and are built of very light, non-corrosive sheet metal, and arranged for either vertical or horizontal positions, the latter arrangement being convenient

for space which would be otherwise wasted in the vessel. The cooled and partially cleansed gas is drawn through the above portion of the plant by a centrifugal gas-cleaning exhauster, driven by direct-connected motor. The gas passes directly from the exhauster under pressure, through an automatic pressure-regulating valve, to the engine manifold.

That the plant is adaptable for marine service with regard to space occupied and weight may be seen from the following conservative estimate: Plants of from 100 to 500 horsepower each occupy from 0.4 to 0.5 square foot per horsepower, and weigh from 70 pounds to 90 pounds per horsepower, including all auxiliaries, piping, etc.; plants of from 500 horsepower to 1,000 horsepower, occupying from 0.3 square foot to 0.45 square foot per horsepower, and weigh from 40 pounds to 70 pounds per horsepower, including all auxiliaries, piping, etc.

Undoubtedly the rational opportunity at the present time for marine gas power lies in commercial service, in which regard the most rapid advancement in America has been made in the freight, ore and fuel carriers of the Great Lakes. We have, therefore, taken for our example a ship built from the designs of Messrs. Babcock & Penton within the last year. For the sake of clearness, the views show only the machinery space; all of the ladders, stairways and grates have been omitted from the plans, and the piping is shown only on the gas installation. The machinery installation proper is all there, however, and while the parts eliminated are merely accessory, the contrast between the two plants would be all the more striking were they included.

The boat is a modern lake freighter, and represents the best standard practice in this service. She is 306 feet long over all, 45 feet beam and 24 feet deep. Her present power equipment consists of a single-screw, triple-expansion, three-crank condensing engine, 18, 30, 50 by 36-inch stroke. She indicates 1,050 horsepower at 90 to 95 revolutions per minute. The engine is of the typical box-front columns and condenser back-frame type. She is fitted with direct-connected air pump and has independent steam-driven, reciprocating, circulating, bilge, sanitary and feed pumps. The complete engine-room weight, including piping and all auxiliaries, is, in round figures, 182,000 pounds.

The boiler-room equipment consists of two single-ended Scotch boilers, 11 feet 10 inches mean diameter each, 11 feet length over heads each, operating on a working pressure of 180 pounds per square inch. Each boiler is fitted with two 42-inch corrugated furnaces, and has 244 2¾-inch tubes. The grate surface is 36¾ square feet, and the heating surface 1,642 square feet in each boiler. The boilers are fitted with forced draft from a 66-inch steam-driven fan. The air for the draft is taken from the stokehole, and the fan is located in the engine room. The fan discharge passes through air heaters in the up-take and thence through ducts to the under side of the grates. The complete boiler-room weight, including water in the boilers, but not fuel, is 170,000 pounds. These weights are actual figures.

The coal bunker extends from the main deck to the tank top, and is arranged athwartship. It has a capacity of 170 tons. The bunker doors face the stokers on the stokehole floor. The bunker is 6 feet fore and aft at the stokehole. The distance from the forward to after bulkhead in the boiler room is 24 feet. The distance from the forward to the after bulkhead in the engine room is 22 feet, making a total over-all length for the plant, including bunkers, of 52 feet.

The coal consumption on this vessel is from 1.08 pounds to 2 pounds per indicated horsepower-hour. This coal is approximately 13,500 British thermal units per pound.

The problem of substitution of gas for steam, aside from the design of the construction of the gas producers or cylinders of the gas engines, has been thoroughly worked out by Messrs. Babcock & Penton, of Cleveland. The illustrations show two different arrangements of gas producers with the same engine. The proposed gas engine is a four-cylinder, double-acting, reversing type, having cylinders 24-inch bore by 36-inch stroke, delivering 1,000 brake-horsepower at 100 revolutions per minute. The reversing is accomplished by means of compressed air, which is used to shift the cams from the ahead to the stern position. Compressed air is admitted to the cylinders by timed cams in proper cycle. The crank shaft of the engine is rigidly coupled to the tail shaft of the screw. The illustrations show a column-framed engine. Since making this layout, the design of the engine has been modified to meet all of the present marine conditions now found in marine-engine design on the lakes. In fact, with the exception of the condenser shown on the steam drawings, the gas engine frame will be very similar to the steam engine.

For the generation of current to drive the auxiliaries, there will be installed a double-cylinder, double-acting gas engine, direct connected to a 50-kilowatt direct-current generator. All of the pumps and auxiliaries will be motor-driven. A smaller direct-connected unit, operating on oil, will be used for pumping, blowing fires or other service when the gas plant is down. Allowing a distance of 4 feet 3 inches between the forward bulkhead in the engine room and the forward side of the fly-wheel, which distance is 1 foot greater than that in the steam installation, we have an over-all distance between forward and after bulkheads in the engine room of 19 feet 6 inches.

As previously stated, two arrangements of producer room are shown. The first, the four-generator plant, consists of four 6-foot by 9-foot generators, each fitted with independent economizers. The forward pair and the after pair are connected independently to two horizontal gas scrubbers, which are shown slung under the main deck beams. The gas passes from these scrubbers to independent, motor-driven, centrifugal, gas-cleaning fans, whence it is delivered, either through common connection to a purge or blow-off pipe, which also acts as a by-pass, or through two gas-pressure regulator valves to the air and gas-mixing valve at the engine manifold. The 6-foot generators require only one cleaning door each. As a result, a single cleaning space suffices for the four machines, allowing them to be grouped with reference to athwartship space, so as to give ample room on each side of the vessel for coal bunkers. The total space occupied by the producer plant is 21 feet 10 inches athwartship, and 15 feet between forward and after bulkheads. The producer room weight, including generators, economizers, piping and scrubbers, complete, of the four-generator set, is 110,000 pounds. This weight is estimated, but has been carefully checked and completely covers all the mechanism. In addition to the above mechanism, there will be a heating boiler, which is shown on the main deck. This boiler will serve to furnish low-pressure steam for heating the vessel and supplying hot water for washing down decks, etc. This boiler, with water, will weigh about 8,000 pounds.

The two-generator producer plant, which will undoubtedly be the one installed, will consist of two 8-foot diameter by 9-foot 6-inch generators, connected to independent air economizers and each fitted with an independent horizontal scrubber, located athwartship under the main deck beams. The gas outlet at the scrubbers will be connected with a cross-over, so that either exhauster may operate either or both producer plants. The exhausters are installed in duplicate, and are connected with common purge or blow-off and common gas outlets, leading either through one pressure-regulator valve or through a by-pass direct to the air and gas-mixing valves at the engine manifold.

On account of the fact that the 8-foot generators require two cleaning doors set at 120 degrees, the double-generator unit plant will require the full athwartship space in the producer room. The approximate floor space occupied, therefore, will be 30 feet athwartship and 15 feet between forward and after

bulkheads. The producer-room weight, including generators, economizers, piping and scrubbers complete for the two-generator set, is 82,000 pounds. This weight is estimated, but has been carefully checked, and completely covers all of the mechanism. As in the case of the four-generator plant, a low-pressure boiler for heating service will be installed. In the two-generator plant, however, this boiler will be located on the producer-operating floor, so that one set of firemen may suffice for both.

The only guide we have for estimating the probable fuel consumption for this service is found in the large number of stationary producer gas power plants now in operation. Fortunately, in marine service, the load factor will be uniformly much higher than that found in any stationary service to which gas power is applied at the present time. The builders of this

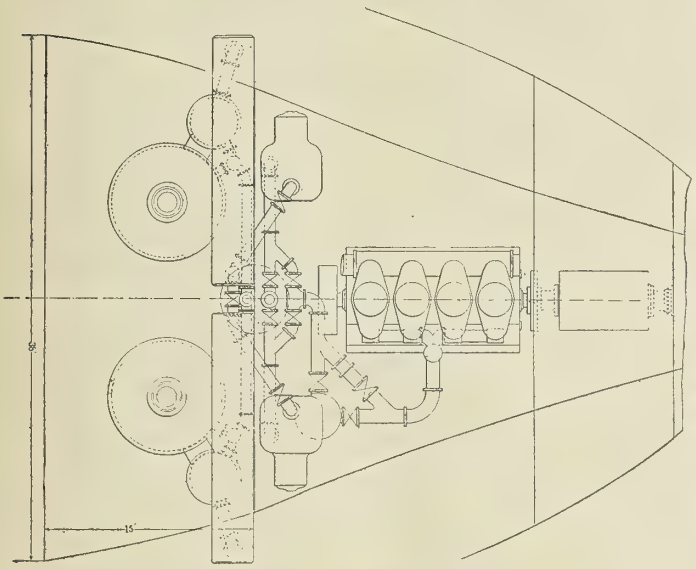


FIG. 5.—PROPOSED TWO-GENERATOR 1,000 HORSEPOWER PLANT.

apparatus are prepared to guarantee 1 brake-horsepower per hour on 1 pound of good bituminous coal, averaging 13,500 British thermal units per pound.

Messrs. Babcock & Penton, the engineers who designed and built the steam plant, and who have spent years on the problem of the substitution of gas for steam, have suggested that the coal bunker, which will be placed above the charging deck of the producer, should have a capacity of about 80 tons of coal. These bunkers will run from the charging deck to the deckhouse, and will have doors opening closely adjacent to the charging doors of the generators, so that little or no coal passing on the operating deck will be required.

In making the comparison shown in the table it is unnecessary to go into the cost of fuel, labor, hours of service, etc., as these elements vary with every class of service. In this particular proposition, it will suffice to state that the engineers who have been working on this substitution problem have conservatively figured that, with the saving in fuel and the increased cargo carried, the cost of the complete plant will be saved in two years of operation.

While the gas plant here described has neither been constructed nor ordered at this writing, its forthcoming will not be long delayed, and this comparison, while somewhat premature, is made to present the possibilities of marine producer-gas power to those interested in its future.

A marine bituminous gas plant, similar in construction and operation to the one described, but of 300-horsepower capacity, has been in commercial operation, driving a six-cylinder, single-acting, reversing marine gas engine for over a year. The results obtained give ample security for the statements made in this paper, and point to the early adoption of this type of prime mover for our marine commercial service.

COMPARISON OF STEAM AND GAS POWER PLANTS FOR GREAT LAKES FREIGHT CARRIER.

Length over all.......306 ft. 0 in. Beam .... 45 ft. 0 in. Depth .... 24 ft. 0 in.	Displacement ....Tons gross. Cargo..4,200 net lb., 18 ft. draft. Speed, 12 statute miles per hour on 900 i.h.p.
STEAM.	GAS.
ENGINE ROOM.	ENGINE ROOM.
3-cylinder triple-expansion, condensing, 18-30-50 by 36 in., 1,050 i.h.p. at 90 to 95 r.p.m.	4-cylinder, 4-cycle, double-acting, gas engine, 24-in- diam., by 36-in. stroke. 1,000 b.h.p. at 95 r.p.m.
Auxiliaries, steam-driven. Length between bulkheads, 22 ft. 0 in. Engine room weights, including auxiliaries and piping, 182,000 lb.	Auxiliaries, motor-driven. Length between bulkheads, 19 ft. 6 in. Engine room weights, 105,000 lbs.
BOILER ROOM.	PRODUCER ROOM.
2 single-ended Scotch boilers fitted with economizers, forced draft. Length, each boiler, overheads 11 ft. 0 in.	Two down-draft gas producers and auxiliaries.
Mean diameter, each, 11 ft. 10 in. Two 42-in. furnaces each. 244 2¾-in. tubes each.	Diameter shell, each generator, 8 ft. 0 in. Inside diameter, lining generator, 6 ft. 3 in. Height shell, each generator, 9 ft. 6 in.
Grate surface, each 36.75 sq. ft. Heating surface, each 1,642 sq. ft. Boiler room weight, water in boilers, no fuel, 170,000 lb.	Grate surface, each generator, 30.67 sq. ft. Producer room weights, no water, no fuel, 82,000 lb.
Length boiler room 24 ft. 0 in. Length boiler room, includes bunkers, 30 ft. 0 in. Square feet boiler room, including bunkers, 900 Square feet per h.p., 0.9	Length producer room, includes bunkers, 15 ft. 0 in. Square feet producer room, 450. Square feet per h.p., 0.45. Square feet producer room with four smaller generators, 330. Square feet per h.p., four generators, 0.33.
Bunker capacity, 340,000 lb. Total weight, machinery and fuel, 692,000 lb. Total length of machinery space, including bunkers, 52 ft. 0 in.	Bunker capacity, 160,000 lb. Total weight, machinery and fuel, 347,000 lb. Total length of machinery space, 34 ft. 6 in. Saving in weight, 355,000 lb. Saving in fore-and-aft length, 17 ft. 6 in. Saving in cubic space 17 ft. 6 in. by 32 ft. beam by 20 ft. high, 11,200 cu. ft.

Some Considerations on the Application of Internal Combustion Engines for Marine Propulsion.*

BY H. C. ANSTEY.

The principal advantages claimed for the internal combustion engine are economy in fuel, weight and space. It is generally conceded that the least economical of internal combustion engines is more economical than the best steam engine, and there are abundant data to substantiate this claim. This factor alone would seem to make it more than probable that the internal combustion engine must play an important part in the future of marine engineering.

On the question of economy of weight and space very little data are available. What little there is is only applicable to small units, and it by no means follows that the results obtained in small units can be applied directly to larger installations. It is to a general consideration of some factors affecting weight and space that the present paper is directed.

Some very remarkable results have been obtained with small petrol (gasoline) engines in respect to power developed on a given weight, but it is to be remembered that this extreme lightness is due principally to two causes, viz.: (1) a high speed of revolution, and (2) the use of special materials of construction. No part of the extreme lightness is due directly

* From a paper read before the Institution of Naval Architects, April, 1909.

to the engine being of the explosive type. The word "directly" is used advisedly, because, as will be seen presently, there are certain conditions incidental to the internal combustion engine which make higher speeds of revolution possible than are possible or advisable with a reciprocating steam engine of similar size.

To arrive at a proper sense of proportion on the question of weight and space, it is desirable to examine it on broad mechanical principles. Of the factors which together make up the horsepower of an engine, the only one which in an engine of given power may be altered without affecting its weight is the number of revolutions, subject always to the consideration that the inertia forces due to the speed are not such as to require special strength and weight of parts and foundations.

If we suppose the mean pressure for a particular engine to be constant and the product of the remaining three factors (viz.: area of cylinder, stroke and revolutions) constant also, it will follow that any increase in speed of revolution will be accompanied by a reduction in area of cylinder, or in length of stroke, or both; and owing to these reductions a saving in weight will be obtained. For an engine of given power, therefore, increase in speed of revolution is accompanied by a reduction in weight per horsepower, or put conversely, an increase in the horsepower per ton of engine weight. Some years ago the author, in examining a number of machinery weights of H. M. ships, found that the engine weight could be divided into two parts, one proportional to the horsepower and the other proportional to the horsepower divided by the number of revolutions. Taking a mean of weights for all the vessels of the same class, in order to eliminate differences in design, the engine weight could be expressed as

$$\frac{I.\ H.\ P.}{k} + k_1 \frac{I.\ H.\ P.}{N},$$

N being the number of revolutions per minute.

The values obtained for the constants k and k_1 gave a close approximation to the actual weights in several classes of vessels, and it was possible to determine with some degree of certainty what increase in weight would be involved in a new design by lengthening the stroke and decreasing the number of revolutions. As to the first term, it is clear that in a steam engine there are items of weight, such as steam pipes, valves, condensers and many others, which will depend upon the weight of steam passing, and hence directly upon the horsepower. The existence of the second term is accounted for by the reasoning previously given.

As these elementary principles are purely mechanical, and, independent of the fluid employed, the formula given above, with suitable values for the constants depending upon the type of engine, will no doubt apply to any reciprocating engine.

Returning to the factors in the formula for horsepower, if we assume piston area, stroke and number of revolutions to be constant, the power is proportional to the mean pressure. The weight of the engine is, however, proportional to the maximum pressure for which the engine has to be designed, and the horsepower per ton is, therefore, proportional to the ratio, mean to maximum. In considering what this ratio is in a marine steam engine we are faced with the difficulty that the power is divided between several cylinders, each having a different ratio of maximum to mean, but for purposes of comparison we shall probably not be far wrong if we assume that the whole of the expansion is carried out in the low-pressure cylinder which develops the whole power and is credited with the whole of the weight. Under this assumption the maximum pressure will be, say, 250 pounds, and the mean 50 pounds, giving a ratio of maximum to mean of 5. This ratio will vary with the ratio of expansion, and will be generally higher in the merchant service than in naval practice. In internal combustion engines, in spite of variety of type, there is not very great variation in this ratio. In the engine with which the author is best acquainted it is approximately 4. In petrol (gasoline) engines it will be rather less, and in engines using a high compression it will be somewhat more. Taking the ratio as 4, it must be corrected for the cycle employed, and as the internal combustion engine has in most types only one working stroke in four, the ratio must be multiplied by four, and the comparative figures will then be, for the steam engine 5, for the internal combustion engine 16; that is to say, considered from the point of view of pressure alone, the horsepower per ton in an internal combustion engine will be 1/3.2 times that of a steam engine of the same linear dimensions.

There are, however, certain factors to be considered which will make the comparison more favorable to the internal combustion engine. First, the items of weight in a steam engine which are directly proportional to the horsepower account for a fair proportion of the total weight, but in the internal combustion engine the proportion of similar parts will be very much less. Steam pipes and condenser, for example, have a counterpart in the air and exhaust silencers, which are not pressure parts, and may be made a quite inconsiderable part of the total weight. Inlet and exhaust valves also will be lighter, in proportion, than the slide valves of a steam engine. Secondly, the single-acting engine of the trunk type is lighter than a double-acting engine of the same diameter and stroke, as the latter requires additional height and heavier parts, due to the piston rod and cross head; hence the horsepower per ton will be, in a double-acting engine, not quite four times what it will be in an engine of the same linear dimensions working on the four-stroke cycle. Thirdly, the internal combustion engine is capable of a higher continuous speed than a steam engine, for two reasons: (1) lighter parts, and (2) lower mean pressures on the bearings. With regard to (1), the following are some weights of reciprocating parts expressed in pounds per square inch of piston area:

High-pressure steam cylinder, 8 inches diameter	2.95
High-pressure steam cylinder, 33 inches diameter	5.46
High-pressure steam cylinder, 40 inches diameter	7.7
Petrol (gasoline) engine, 4 5/16 inches diameter	0.63
Oil engine, 9¾ inches diameter	1.45
Oil engine, 15 inches diameter	2.2
Gas engine, 24 inches diameter	4.0

With regard to (2), the sizes of journals in internal combustion engines are larger than those of steam engines of the same power, and although the maximum pressures on them may be as high in the one case as in the other, the mean pressure in the internal combustion engine will be much less, as there is only one working stroke in four.

If we assume that the satisfactory working of a bearing depends upon the product of pressure and velocity not exceeding a safe limit, it will follow that the lower the pressure the higher the speed at which the bearing can be run, and this rule will be found to be generally observed when we compare steam and internal combustion engines used for such work on shore, where the design has become standardized to the requirements. For example, a certain 10-horsepower (nominal) steam engine runs at 135 revolutions per minute, while a 20-brake horsepower oil engine, which is capable of doing the same work, runs at 245 revolutions.

Taking the three factors, lighter accessories, lighter parts and higher possible speeds of revolution into consideration, it would appear that the figure 1/3.2, which was arrived at from considerations of maximum and mean pressures alone, can be considerably increased. How much it may be increased is more or less a matter of conjecture, but it will possibly be of the order of 1/1.5 to 1/2.5, so that for engines of the same linear dimensions the horsepower per ton will in the internal

combustion engine only be one-half that in a steam engine.

So far we have left out of account the question of weight of boilers and their accessories. These will have a counterpart in the gas producers for the gas engine, but have no equivalent in the oil engine. So far as the gas engine is concerned, the weight and space required for producers is largely dependent upon the type of fuel used and the cleaning arrangements necessary to deal with the gas, and this is too large a subject for the present paper. As the weight of boilers is usually about equal to the weight of engines, it follows from the above conclusion that the horsepower per ton will, for the complete installation, be about equal to that of an oil engine of the same linear dimensions as the steam engine. It is possible that there may be some saving, but it appears certain that if the internal combustion engine is to develop on lines parallel to that of the steam engine, that is, with few cylinders, there will be no very great saving, such as has sometimes been imagined by inference from the results obtained with small-sized units, where the speed of revolution is high. The difference in operating condition of large and small units will depend directly upon the speed.

The limit of speed of revolution will generally be determined by the inertia forces, and these have to be considered first as separate forces requiring adequate strength of the individual parts; and, secondly, in combination with a view of making their algebraic sum as nearly zero as possible. With a sufficient number of cylinders complete balance is comparatively easy to obtain, but the individual forces still remain, and must be provided for. It is usual to assume that the inertia forces, expressed in pounds per square inch of piston area, should be less than the compression pressure, in order to avoid shock due to reversal of stress when combustion follows at the end of compression. It is argued that there is no reversal of stress on the idle strokes (suction and exhaust), but this is only true if we neglect the effect of friction of the piston and slackness in the bearings. It is well to remember, when considering the possibility of shock, that the effect of the load suddenly applied is double that of a load steadily applied, and, further, that the calculation for inertia force can only be made on the assumption of uniform angular velocity of the crank, an assumption probably some distance from the truth in any reciprocating engine. The safe rule is to keep the calculated inertia force per square inch of piston as low as practicable, and if we assign a limit to this, which, from present experience, the author would be inclined to put at 100 pounds, we obtain a formula of the following kind:

$$w \times l \times N^2 = \text{constant}$$

where w is weight in pounds of reciprocating parts per square inch of piston area, l is stroke, and N number of revolutions per minute. This may also be written

$$w \times P \times N = \text{constant}$$

where P is the piston speed; from which it follows that, at constant piston speed, the permissible speed of revolution varies inversely as the weight of reciprocating parts per square inch of piston. The permissible speed of revolution can be connected with the diameter of cylinder in the following manner. If we look at the table of weights given above, we find that the reciprocating weights per square inch of piston increase with the diameter ,and are approximately proportional thereto. This is reasonable, for if we take one part, say the base of a piston, for example, its weight will vary as its area and thickness; and as, for equal strength, the thickness will vary as the diameter, the weight will vary as the cube of the diameter; hence per square inch of piston the weight will vary as the diameter. It will be found that similar rules hold good for other reciprocating parts. Hence, if as found above,

$$w \times N = \text{constant, for constant piston speed,}$$

and if w varies as d, the diameter of cylinder, then

$$d \times N = \text{constant};$$

that is, for a given piston speed the permissible speed of revolution varies inversely as the diameter. It follows, therefore, that a necessary condition of high speed of revolution and higher power per ton of weight is a small diameter of cylinder.

This reasoning is applicable to engines designed for a particular maximum pressure, but it can be extended to varying pressures by considering that the weights per square inch of piston will vary approximately as the pressure. If P_1 be the maximum pressure we may write

$$d \times N \times P_1 = \text{constant};$$

that is, the higher the maximum pressure the lower the permissible speed of revolution with a given diameter of cylinder.

This relationship may be called a mechanical law of comparison, and may be applied approximately to determine the relative weights of engines of different dimensions. If we suppose, for example, a petrol (gasoline) engine of, say, 4 inches cylinder diameter and 5 inches stroke and at 1,200 revolutions to give 100 horsepower per ton, and if we take such an engine as a model for one ten times the linear dimensions, the diameter will be 40 inches, the stroke 50 inches, the allowable revolutions will be 120 and the horsepower per ton will be 10.

A modern marine steam engine having these dimensions for its high-pressure cylinder will give (engine weight only) about 20 horsepower per ton, or double the horsepower per ton of the internal combustion engine of the same linear dimensions—a conclusion arrived at previously by a different method of reasoning.

The direction in which light weight is to be sought lies in keeping down the diameter of the cylinder, thus allowing a higher speed of revolution; but for large powers this involves a large number of cylinders. That a larger number of cylinders than usual with steam practice is inevitable is apparent from considerations of uniformity of turning moment, but how far the number can be advisedly increased can only be determined by experience. Up to the present, sixteen cylinders have been used on one shaft, and there seems no reason why this number should not be increased by successive steps of four or more cylinders at each step. The powers, however, which have been obtained per cylinder in engines whose design admits of application to propulsion are not large, probably not exceeding 100 horsepower, and until the unit is largely increased the very large powers required in many present-day vessels are out of reach of the internal combustion engine, the immediate application of which would appear to be concerned mainly in the propulsion of boats and small vessels. In powers, say, of 500 horsepower on one shaft, it appears reasonable to expect 12 to 15 horsepower per ton of machinery weight, and though this is low compared with larger powered engines for naval work, it is higher than the ordinary run of merchant-service practice. The figures given above refer to a complete installation of oil engines, without auxiliaries; the weights will be greater with gas engines, for the reasons already given.

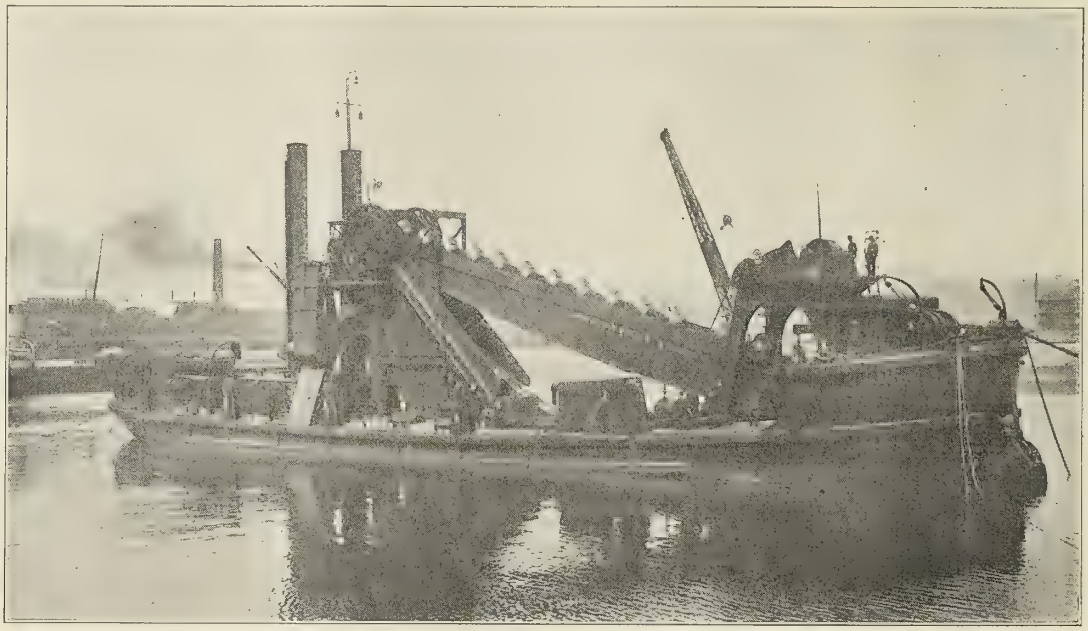
In connection with the use of a large number of cylinders, some reference should be made to the proposals which have been made from time to time for transmitting power from engine to propeller electrically. By this means the total power can be split up into a number of convenient units, and a much larger number of cylinders can be employed than is immediately practicable to place together on one or two shafts with direct coupling to the propellers. The weight of the engine per horsepower is thus kept low, but, on the other hand, the extra weight due to the addition of dynamos and motors to the installation will counteract the saving due to the large number of cylinders of small diameter. There are the further disadvantages of increased cost and higher fuel consumption per shaft horsepower. On the other hand, the system appears to be the only one at present practicable by which the internal

combustion engine can be applied to the propulsion of vessels requiring several thousand horsepower.

The author has made an approximate estimate of the weight of such an installation for 3,000 horsepower. The total power is supposed to be generated by ten equal-sized electric sets of 300 horsepower, or, say, 200 kilowatts each, running in parallel with one another, and the vessel propelled by three shafts, each fitted with a 1,000-horsepower variable speed reversing motor. The weight of the generating sets would be approximately 240 tons, and the weight of the three motors with bedplates, 43 tons. Switchboards, cables, shafting and propellers would probably require not less than 17 tons, making the total weight about, but not less than, 300 tons; and of this weight, approximately one-third would be due to the electrical portion. This weight is exclusive of auxiliary machinery, the installation of which in a large vessel propelled by internal combustion engines would give rise to a number of problems of some importance, particularly with regard to steering apparatus.

applicable to larger engines of this type. With such a reversing engine there is a possibility of considerable saving in space over steam machinery, and as compared with mercantile practice, some appreciable saving in weight without reference to saving in quantity of fuel carried.

The main claims, however, which the internal combustion engine has for consideration are in the superior fuel economy and smaller number of men required for working, and these claims are so unquestionable that there appears no reasonable doubt that it must eventually, in a large number of cases, take the place of steam machinery at sea, as it is now doing on land. The author has endeavored to place the question of weight and space required for internal combustion engines in its true perspective, and although the saving, particularly in space, will in most cases be real, he would repeat that, on the whole, there will be no great saving in weight such as has sometimes been imagined by inference from results obtained in small units.



BOW-WELL, CENTER-LADDER, BARGE-LOADING BUCKET DREDGER SHIELDHILL.

The total floor space required for the generating sets would be about 1,500 square feet, or 2 horsepower per square foot. This is probably somewhat better than the results obtained with steam engines and cylindrical boilers as fitted in the mercantile marine, but it does not compare favorably with the space required for engines and watertube boilers, as used in naval work. The problem of electric propulsion is one of great interest, and its adoption in special circumstances may be justified, but it would seem that generally it does not offer sufficient commercial advantages for mercantile work, and, on the other hand, for naval work it cannot compete with existing steam machinery in the all-important considerations of weight and space. The question of the economical application of the internal combustion engine to propulsion in large sizes, whether the economy is viewed from the standpoint of cost, weight or space, is largely bound up with the problem of making a reliable reversing engine. In small sizes, the familiar devices of reversing propeller or reversing clutch will, no doubt, do all that is required, but few, if any, marine engineers would care to contemplate their adoption in thousands or even several hundreds of horsepower.

An account of a successful experiment in a reversing engine of 80-brake horsepower of the Hornsby type has been given by the author in another place.* The method there described is

* Proceedings Inst. Civil Engineers, Vol. CLXVIII.

THE BUCKET DREDGER SHIELDHILL.

This vessel is the largest and heaviest dredger owned by the Clyde Trust. She was built by Ferguson Bros., Port Glasgow, and is of the bow-well, center-ladder, barge-loading type of the following dimensions: Length, 198 feet; breadth, molded, 39 feet; depth, molded, 13 feet; dredging capacity, 1,000 tons per hour from a depth of 50 feet below the water level.

Separate accommodation is provided below for the captain, engineers, crew and laddermen, fitted up in comfortable style, with a very complete outfit, special provision being made for light and ventilation.

Steam steering gear is fitted at the after end of the engine casing, controlled from the main bridge on top of the main gear framing. This gear has been supplied by Messrs. Alley & McLellan, Glasgow. A complete electric light installation is fitted throughout, large clusters being fitted on deck for night work.

Heavy elm beltings are fitted all round the vessel, also strong, vertical fenders at intervals to take the wear of the barges alongside.

A raised forecastle is formed for the purpose of strongly tying the two sides of the vessel across the ladder well, and the bucket ladder projects sufficiently in advance of the hull to enable the dredger to cut her own flotation. The bucket

ladder is of sufficient length to dredge to 50 feet, and is suspended in heavy bearings independent of the tumbler. The scantlings are of the heaviest description, and all riveting has been done by hydraulic power. The lower ends of the ladder are specially arranged to take side thrust, and are fitted with connections for oil or grease lubrication, for this purpose pipes being led to pumping apparatus fitted in main engine room.

The framings have been constructed of the best class of girder work of exceptional strength, to withstand the strains when dredging, and riveted with steel rivets closed by hydraulic pressure.

Side shoots are arranged for discharging the dredged material over either side of the vessel into hopper barges, the lifting and lowering of these shoots being worked by a separate, vertical engine, placed amidships, complete with all brakes, barrels, etc.

The two sets of main propelling and dredging engines are of the compound, three-cylinder, three-crank type, using steam at a working pressure of 130 pounds per square inch. The indicated horsepower is 1,100. The auxiliaries include a steam reversing gear, an automatic Weir feed pump, a heater, feed filter, donkey pumps, centrifugal circulating and auxiliary air pumps, in addition to the main engine air pumps. Steam is supplied by two large multi-tubular marine boilers. Telegraphs and speaking tubes are fitted from the various controlling bridges to the engine room, mooring winches and hoisting gear. These have been supplied by Messrs. Wilkinson & Lynch, of Glasgow and Liverpool.

The dredging machinery is of massive design for working in the hardest of materials. The vessel is supplied with two sets of buckets of different capacities, constructed of exceptionally heavy material. The smaller set is intended to be used for dredging material which has been blasted before dredging. The driving gear is of cast steel throughout, the spur wheels being machine cut, and arranged to give a fast and slow speed for soft or hard material, as desired, with the engines running at a constant speed. A large steam crane is fitted on deck for overhauling the buckets and for general purposes.

The hoisting gear for the bucket ladder consists of heavy wire-rope tackle, working in upper and lower sheave blocks suspended from a cross-head fixed on a box-framing structure built into the forward end of the vessel. The lower sheave blocks are connected to the bucket ladder by strong, forged side rods. The wire rope is wound on a large grooved barrel, driven by gearing from a double-cylinder vertical engine, all placed under the deck. The gearing between the engine and barrel is of the sun and planet motion type, controlled by double-friction brakes, actuated with a compound lever for holding, lowering or heaving the load, as desired, the engine being free to run either with or without the load. The wheels and handles for working this gear are placed on deck, under the control of the dredging master. The wire rope is 6½ inches, made of special flexible plow steel.

Powerful steam winches are placed at the bow and stern for manipulating the mooring chains and holding the dredger up to its work. The forward winch has six barrels and the stern winch five. All the clutches are of the Mather & Platt type. Each winch is driven by an independent vertical two-cylinder engine.

Secretary of the Navy Meyer has announced that the voyage of the sixteen American battleships around the world involved an outlay of only $1,500,000 more than would have been necessary had the fleet spent the time occupied on the voyage in home waters, either at anchor or cruising, or engaged in the customary maneuvers. For such a small outlay this is certainly one of the most satisfactory investments that any nation could make.

WATERTIGHT SUBDIVISION.

BY ARTHUR R. LIDDELL.

The loss of the *Republic* has once more called attention to the question of the watertight subdivision of passenger vessels, and again the demand is made for comfortable floating hotels which, while able to cross the ferry in the smallest possible time, can neither be capsized nor sunk. Unfortunately these different qualities do not always agree very well. Comfort means a low metacentric height; that is to say, relatively good chance of capsize when the vessel is rammed amidships. High speed means large spaces for machinery, etc., which do not admit of unlimited subdivision. Again, if the vessel in question has to carry cargo, her holds cannot be unduly reduced in length unless she is to refuse a large proportion of the goods offered to her for transport.

The *Republic* was arranged in the ordinary manner with probably about the degree of subdivision usual for her size. Now, in small vessels it is practically impossible to fit more than the four bulkheads possessed by every tramp. A fifth bulkhead becomes possible in a vessel of about 300 feet in length, and each step of about 50 feet to 70 feet in length, according to size of vessel, enables one more to be added. With the exception of the Germanischer Lloyd, which prescribes limits for the lengths of the various compartments, the Classification Societies in general content themselves with specifying a certain number of bulkheads. It is customary, indeed, in the design of a passenger vessel, to calculate whether she will float with one, or perhaps two compartments flooded, but the loss of the *Republic* has shown once more that subdivision as practiced or practicable does not obviate every danger. The theory of watertight subdivision is that, when one or perhaps two compartments are flooded, the upper deck may, at the lowest point, be just about awash.

Now, assuming that the vessel has sufficient stability in this condition, that her bulkheads hold out, and that the sea is calm, she may have a fair chance of getting to land, or at any rate of keeping above water till help arrives, but if the sea be rough she will be in a very sorry plight. A long vessel floating among waves of her own length will have her deck at the lowest point continually under water. The half height of a wave 800 feet long may be about 20 feet. Such a wave would almost reach the deck of the poop or forecastle of a vessel of the same length, and if the latter sank, say, 10 feet deeper at any part as the result of a collision, the wave would there rise nearly 10 feet above such erection. Whether hatch coamings, deck erections, etc., would then hold out, would be extremely doubtful. Steaming would probably be out of the question. The fact is that most of the precautions invented to allay the fears of timid travelers apply only to fair weather conditions, and to places that are not very far from land, where, after all, most of the collisions occur.

From such accounts as have been published hitherto, it would appear that the flooding of the engine room alone would not have sunk the *Republic*, but that either the after bulkhead of this compartment or the doors in it had not held sufficiently tight. In spite of innumerable closing appliances that are patented or actually applied in practice, bulkhead doors are unfortunately still a weak point. To make quite sure that the vertical sliding doors will be always ready for use and the crew well parcticed in their manipulation, it is customary to institute bulkhead-door drills at more or less short intervals, when the doors are allowed to fall at the word of command and emergency conditions are as far as possible taken account of. The heavy doors fall with very considerable force, and the frequent repetition of this maneuver is apt to jam them so that they are difficult to raise again; it has, indeed, in some cases been known to split the

frames. To prevent this it is the practice in some vessels to insert wooden chocks across the sills for the doors to fall upon. These also prevent the grooves for the doors being filled with dirt, and they are apt to be left in place, to be removed when a real emergency arises. Now when the green sea comes into the engine room, there is not much time for such removals; the chocks are apt to remain in place and the doors to be let fall upon them. Needless to say the latter do not shut tightly and can no longer be made to do so, even if any one be alive to the cause of the leakage. The leak may in such a case still be kept down, if only pumps are available, and such a vessel as the *Republic* is in this respect well provided. The engineers of this vessel consider that they could, under ordinary conditions, easily have kept her afloat till she got to land, but unfortunately the pumps were in the flooded compartment below the waterline, and neither they nor the engines could be made use of.

There are a good many cases on record in which the engine room of a steamer has been flooded, and it seems worthy of consideration, whether parts of the machinery, such as water-tube boilers, pumps, etc., could not with advantage be arranged on deck, as has at different times been proposed—notably by Herr Leux, of the firm of F. Schichau in Elbing. It has long been a difficulty in the design of a fast steamer to find room for all the boilers, and if the placing of some of them on deck would displace a few passenger berths, the extra safety and other advantages incidental to this arrangement may be looked upon as an important off-set against the accommodation lost. The late Mr. H. H. West, of Liverpool, once proposed to fit passenger accommodations in the holds of vessels. In these days of the electric light, he considered a berth without a window was no longer the unpleasant resort that it used to be. True, a berth with daylight is to be preferred to one without, but many a passenger would gladly put up with good artificial light for perhaps a somewhat lower fare.

The great point is that the public should realize that absolute unsinkability can be obtained only at the expense of all or of most of the advantages for the sake of which a seagoing vessel exists, and that an insistence upon its provision would practically put a stop to ocean traveling. And after all, though the loss of a large passenger steamer is a more sensational and appalling event than, say, a hundred or so railway or carriage accidents, the chances of destruction undergone by a single passenger are probably no greater on the sea than on land.

We are accustomed to hear of the compromise between different qualities represented by the design of a war vessel; this state of things has its exact counterpart in passenger vessels. By all means let us have a collision bulkhead and a reasonable amount of subdivision by well-arranged bulkheads, but do not let us forget that any additional immunity from the various dangers of the sea has to be dearly paid for in money, time, or comfort, or perhaps in all these combined.

The Monaco Race Meet.

The two most interesting events at the sixth annual motor boat exhibition and race meet, held at Monaco in April, were the 50-kilometer race for the Prize of Monte Carlo, and the 100-kilometer race for the "Coupe des Nations." The former event was won by the English boat *Wolseley-Siddeley,* which covered the distance, 50 kilometers (31.07 miles), in 45 minutes and 4/5 seconds, or at an average speed of 38.04 miles an hour. In the "Coupe des Nations," which was over a course 100 kilometers (62.1 miles) long, the *Wolseley-Siddeley* made even better time, winning the race with an average speed of 39.15 miles an hour, and covering one lap of the course at a speed of 40.6 miles an hour.

Practical Experience with the Parsons Marine Steam Turbine on the Ben-My-Chree.*

BY J. C. BLACKBURN.

In respect to size, passenger-carrying capacity and speed, the turbine passenger steamer *Ben-My-Chree,* built by Messrs. Vickers, Sons & Maxim, Ltd., of Barrow, for the Isle of Man Steam Packet Company, represents a marked advance over all channel steamers preceding her. She is 375 feet long, with a breadth of 46 feet, a depth of 18 feet 6 inches, and a designed speed of 24 knots. Accommodations are provided for 2,549 passengers.

The ship is very strongly built to the requirements of Lloyd's and the Board of Trade. The builders have been most successful in the form and arrangements for stiffening the hull aft. The water ballast tanks are carried on each side of the shaft space, and the fore and aft bulkheads shown in Fig. 2, forming the sides of these tanks, provide a very efficient stiffening for the decks, the result being the lessening of vibration. There are eleven watertight compartments, and five of the bulkheads are fitted with watertight doors on the Stone-Lloyd system, which allows of their being closed from the bridge or from below. The ship is capable of floating with any two compartments flooded.

A bow rudder, worked by steam gear, is fitted to facilitate maneuvering operations. For the stern rudder there is a combined steam and hand gear, the steering engine aft being operated by telemotor gear from the bridge.

Very wide alleyways are provided on the decks, with the result that even when carrying the full complement of 2,549 passengers there is ample space for walking about.

THE BOILERS.

There are four double-ended boilers, 16 feet 9 inches diameter, 20 feet 7½ inches long, with eight furnaces, 3 feet 6 inches diameter in each, fitted with common combustion chambers. The working pressure is 170 pounds per square inch. Grate area, 754 square feet; heating surface, 27,446 square feet.

THE TURBINES.

The turbines are arranged on three shafts, the high pressure driving the center shaft and the two low pressure driving the wing shafts. Astern turbines are incorporated in the casing with each low-pressure turbine. The starboard and center propellers are right-handed, and the port left-handed. The diameter of the rotor drum of the high-pressure turbine is 3 feet 11 inches, the low pressure 5 feet 7 inches, and the astern rotor drums 4 feet 2 inches. Each low-pressure turbine exhausts into a separate condenser, the total cooling surface in the two condensers being 14,348 square feet.

The two circulating pumps are of the centrifugal type, each driven by a separate reciprocating engine, the suction and delivery pipes being 23 inches diameter. The air pumps are of the direct-acting twin type, fitted in duplicate for each condenser, the diameter of each pump being 33 inches and the stroke 18 inches. The exhaust steam from the auxiliaries is led into a surface heater by which the temperature of the feed water is raised to 160 degrees.

While on the six hours' trial, the ship maintained an average speed of 24½ knots with ease, and for a portion of the run her speed was 25½ knots. An astern speed of 16.6 knots was attained on the measured mile, and stopping and turning operations were accomplished in a very satisfactory manner. From going 23 knots ahead the ship was brought to rest in a distance of three of her own lengths. It was noticed that the power necessary for propelling the ship astern was about twice that required for going ahead at the same speed.

* From a paper read before the Institution of Naval Architects, April, 1909.

The general arrangement of the engine room is shown in Fig. 1, and has proved most convenient. Turbine engine rooms are usually extremely hot, but a great improvement in this respect is noticeable in the *Ben-My-Chree,* due to the large hatchway and the efficient lagging of the turbine casings. This lagging is arranged on an improved design, the result being a very small loss of heat by radiation, as shown by the fact that the planished steel covering plates of the high-pressure turbine are no more than blood heat at full power. This result is obtained by supporting the magnesia lagging blocks so as to give an air space of 3 inches to 4 inches between their under surface and the surface of the cylinders. There is an electric fan in each of the forward ventilators in the vicinity of the starting platform, and these largely increase the amount of fresh air entering the engine room.

The propellers are three-bladed, and made specially large to insure good maneuvering powers; they are all three of the same dimensions, viz.: diameter, 7 feet 2 inches; pitch, 6 feet 8 inches.

The work done on service is shown by the extract from the official engine-room log, giving the speed for each run in Table I. The mean speed for ten consecutive runs in deep water between the Liverpool Bar and Douglas Head was 24.12 knots. The speed of all vessels has to be slackened between the Liverpool Bar and the Rock Light while passing dredgers; and the shoal water of the channel, especially at low tide, tends to reduce speed to a very considerable extent. In spite of this, and of the still further reductions of speed on approaching the landing stage, the average for the total distance is 23 knots. The mean draft of the ship during these runs was 13 feet 5 inches, and the displacement 3,353 tons. The mean air pressure in the stokeholds was less than 1 inch water column.

The coal consumption is obtained by dividing the total weight of coal put on board by the number of trips, and includes the coal used each day at Liverpool in going from the stage to anchorage, coal used while at anchor, coaling bars in the morning, making up fires and steaming to the stage. The total of all this has been carefully measured, and amounts to 24 tons per day; this deducted from 95, gives 71 tons consumed per day on two trips, and, as the mean horsepower is 14,700, it works out to 1.87 pounds per horsepower per hour. This consumption, of course, includes the coal used in raising steam for the various culinary purposes on all parts of the ship. Lancashire coal is used throughout.

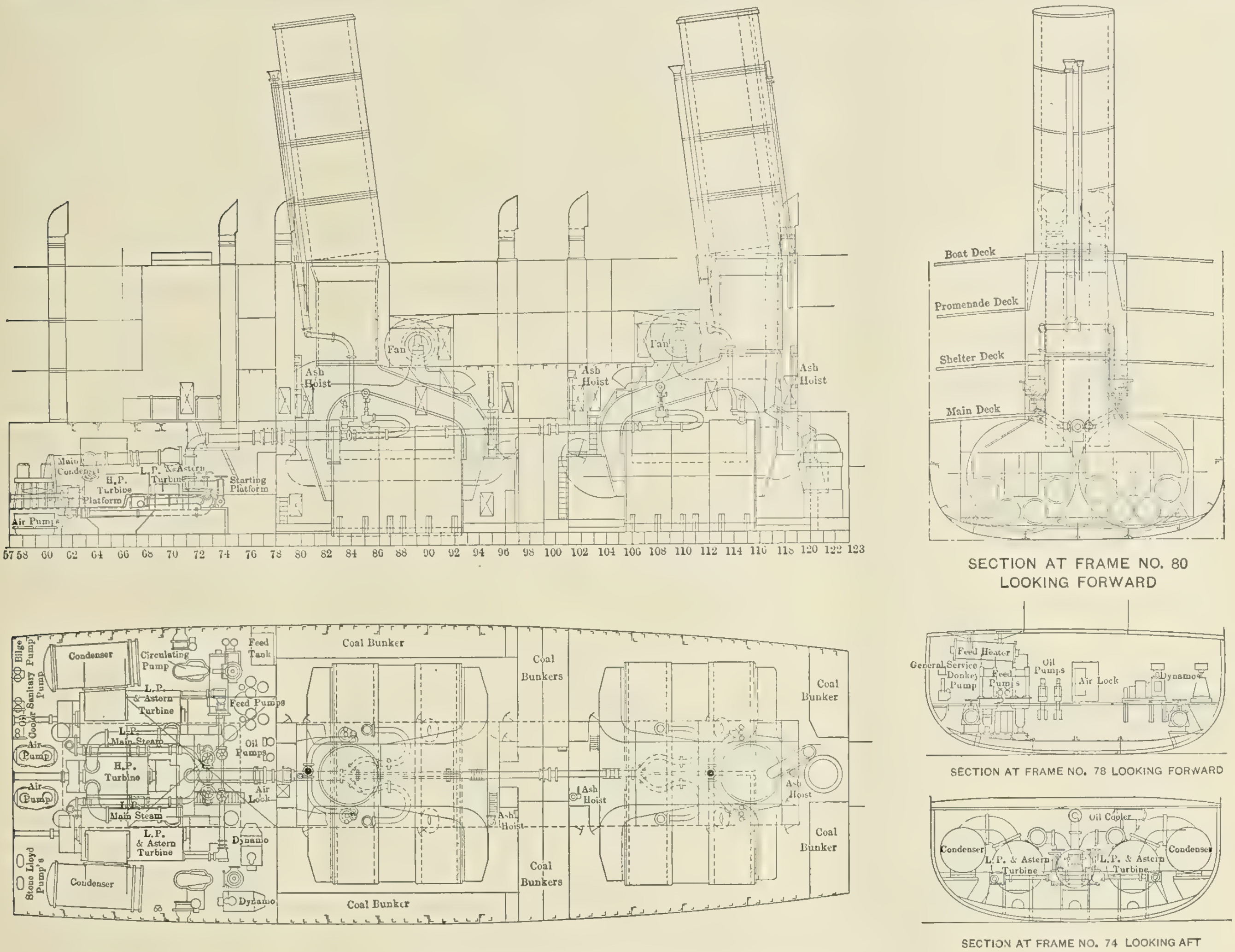


FIG. 1.—MACHINERY ARRANGEMENT OF THE BEN-MY-CHREE.

A noticeable fact is that the number of revolutions is almost identical in the case of each of the three turbines. In looking over the results obtained the following points may be noted:

REGULARITY OF RUNS.

This is due largely to the fact that we had dry steam during the whole of the time. At no period, either during the trials or on service, was there the least indication of the boilers priming. The Isle of Man Steam Packet Company have had a long experience with paddle-wheel steamers, and have adopted an arrangement of corrugated steel anti-priming plates in the new boilers of their ships. These plates are secured to the fore and aft stays of the boilers at the water

level. Their good effect in preventing priming has been proved beyond doubt. We have adopted a similar arrangement in the boilers of the *Viking* and *Ben-My-Chree*, knowing how liable new boilers are to produce wet steam. I am convinced that to this cause is due much of the credit of the splendid performances of these two vessels. The disadvantages of wet steam are as great in the case of turbines as in reciprocating engines. Wet steam contains initially less internal energy, and the re-evaporation that must take place in the latter stages of the expansions is bound to reduce the useful work which the steam is capable of giving out. The engineer in charge of a steam turbine is very promptly made aware of the fact when priming takes place, and also when steam is wet. The agreeable whistling sound that is an indication to him that all is well has gone, a reduction in the revolutions is soon apparent, and the glands at once indicate the presence of water.

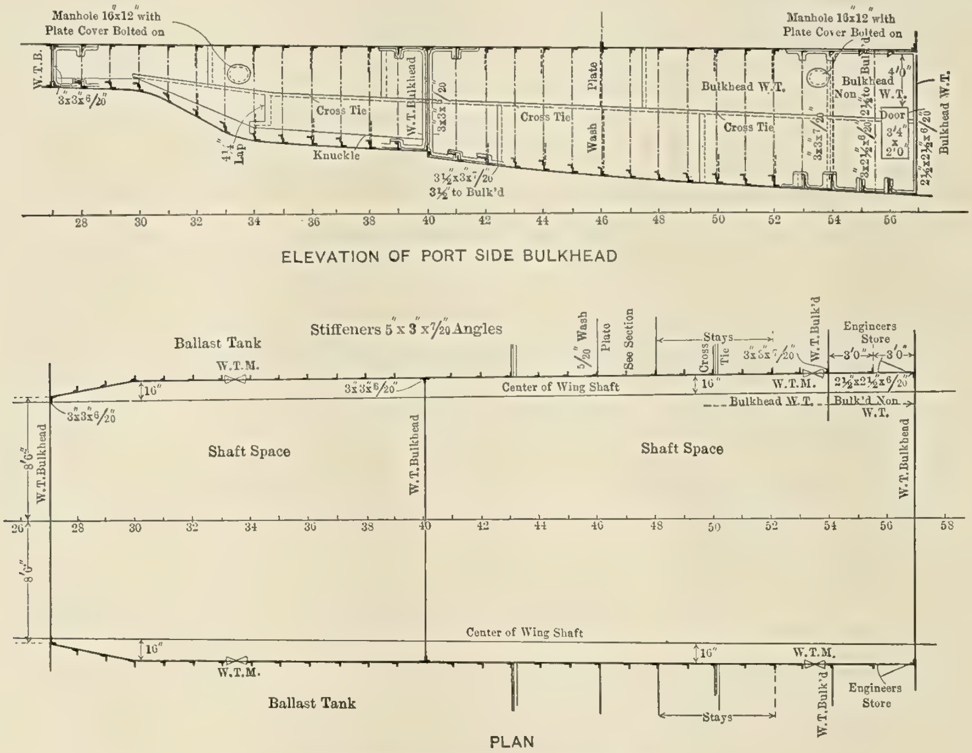


FIG. 2.—BALLAST TANK BULKHEADS AFT.

LUBRICATION.

Very careful attention has been paid to the distribution of oil in the bearings. The pressure in the pipes is 45 pounds. The oil enters the cooler at 126 degrees and leaves at 110 degrees. The cooler is of the surface-condenser type, the oil traversing the tubes four times. The tunnel shaft bearings are 9 inches diameter and 18 inches long, and have water circulation. The lubrication by the usual syphon wool is supplemented by a necklace of plaited lampwick at the fore or high end of the bearing, which revolves with the shaft and dips into an oil bath. No appreciable wear has taken place on any of the turbine bearings, and there has been no heating.

MANEUVERING POWERS OF TURBINE STEAMERS.

Having had experience of the handiness of paddlers, the Isle of Man Steam Packet Company were dubious as to how the turbines would fulfill their requirements in this respect, but the results, I am glad to say, have removed all doubts on this score. The ship has run through the season, taking the piers most satisfactorily, and has not sustained the slightest damage. Taking into consideration the exposed position of Douglas Pier, and the difficulty of berthing at the Liverpool landing stage when the big Atlantic liners are alongside, it speaks well for the maneuvering powers of so large a steamer that she has come through without a scratch. On any day during the season the *Ben-My-Chree* may be seen performing a very expeditious maneuver. The time occupied in backing out with the bow rudder (a distance of about ¼ mile from the pier), in stopping and getting under way until she is again in line with the pier, averages four minutes. This for a vessel of her dimensions could hardly be improved upon by any other method of propulsion.

OVERHAUL.

The *Ben-My-Chree* is well equipped with lifting gear, and the opening up of the turbines for survey has been carried out at a comparatively small cost by the ship's engineers and firemen. The internal condition of the turbines was most satisfactory, the blading throughout being in perfect condition, quite clean and free from any obstructive matter in the spacing. The spliced Ramsbottom gland rings, which had been fitted instead of the ordinary Ramsbottom rings, have proved, along with the radial gland strips, most efficient, and were in perfect condition, with the exception of two rings, which were slightly worn, and which were renewed.

The only parts of the three turbines that showed any defects were the radial dummy strips of the port low-pressure turbine, five out of ten of which were flattened through rubbing against the casing. The reason for this remains a mystery, as the other low-pressure turbine was in perfect condition.

CONDENSERS.

These remained perfectly tight throughout the season, and were tight when tested at the finish. The vacuum averaged 27½ inches, the augmentary condensers contributing on an average 1 inch to this.

With a view to facilitating the testing of turbine steamers' condensers while on service, a distance piece has been introduced between the flange of the exhaust bend and the condenser flange, to which a sectional blank flange can be bolted. The importance of being able to fill the condenser for testing

T.S.S. "BEN-MY-CHREE." ABSTRACT OF ENGINE-ROOM LOG.

Averages for 10 Consecutive Trips on Liverpool Service, from July 21 to 27, 1908.

Date	Sailed.		On Passage.		Head and Rock.		Head and Bar.		Hours Under Steam.	Pressure of Steam.					Vacuum in inches.		Revolutions per Minute.			Coal per trip
1908.	From.	To	Time.	Speed.	Time.	Speed.	Time.	Speed.		Boiler.	Main Steam Pipe.	H. P. Receiver.	P. L. P. Receiver.	S. L. P. Receiver.	Port.	Starboard.	H. P.	P. L. P.	S. L. P.	Tons.
July			hs. mns.	Knots.	hs. mns.	knots.	hs. mns.	knots.												
*21	Douglas	Liverpool	3 6	22.33	2 57	22.80	2 20	24.00	6	165	143	127	18	18	28	27	454	460	460	47½
22	Liverpool	Douglas	3 5	22.46	2 57	22.80	2 22	23.66	6	165	147	137	20	20	27½	27	455	460	455	47½
†22	Douglas	Liverpool	3 1	22.96	2 53	23.32	2 19	24.17	6	165	145	130	18	18	27	26¾	450	455	450	47½
23	Liverpool	Douglas	2 58	23.34	2 53	23.32	2 18	24.34	6	165	150	142	22	21½	27½	27	459	465	463	47½
‡23	Douglas	Liverpool	2 57	23.47	2 50	23.73	2 18	24.34	6	165	147	135	20	20	27½	27	455	460	455	47½
24	Liverpool	Douglas	2 56	23.61	2 51	23.60	2 16	24.71	6	165	145	140	21	21	27¾	27¼	460	465	460	47½
24	Douglas	Liverpool	3 1	22.96	2 53	23.32	2 20	24.00	6	160	145	130	19	19	27	27	457	460	460	47½
§25	Liverpool	Douglas	3 1	22.96	2 53	23.32	2 19	24.17	6	165	152	136	20	20	27½	27⅛	455	460	460	47½
25	Douglas	Liverpool	3 3	22.70	2 54	23.19	2 21	23.83	6	160	143	127	18	18	27¼	27⅛	445	450	445	47½
¶27	Liverpool	Douglas	3 1	22.96	2 53	23.32	2 20	24.00	6	165	148	130	20	20	28	27	450	460	455	47½
Average for 10 Consecutive trips....			3 0.9	22.96	2 53.4	23.27	2 19.3	24.12	6	164	146.5	133.4	19.6	19.5	27.5	27	454	459	456	47½

Remarks.—July 21.—*Going at reduced speed between Bar Ship and Rock Light through low water in channel. July 22.—†Reduced speed between Rock and Bar Ship on both passages, through low water in channel ‡ Record passage to date between Head and Rock. § Delayed off Douglas for 5 mins. through fog. ¶ (26th Sunday.).

Distances:—Douglas Head to Stage.................. 69¼ nautical miles
Douglas Head to Rock.................. 67¼ "
Douglas Head to Bar.................. 53 "

Coal Consumption.

Total consumption for one day........................		95 tons
Coaling bars...........................	8½ tons	
Making up fires...........................	10½ "	24 "
Consumed at anchor........................	5 "	71
Consumed on single passage (71 ÷ 2)..................		35.5 "

Coal Consumption for Indicated Horsepower.

Horsepower....................................	14,700
Revolutions per minute............................	454
Time between Head and Rock (2 hrs. 53.4 mins.)......	2.89 hrs.
Coal consumption between Head and Rock (35.5 tons).......	79,520 lbs.
Coal consumption per horsepower per hour.............	1.87 lbs.

purposes, without filling the low-pressure turbine, will be readily appreciated by those who have had to do with turbine steamers. The condensers must be kept tight, otherwise evils arise; a leaky condenser frequently causing priming.

LYING UP.

As steamers of the class referred to are idle for about six to eight months of the year, it is necessary to take precautions against deterioration during this period. It is advisable to open up the casings as soon after the ship is laid up as possible, then with wire brushes to remove all rust and light scale from the interior of the rotor and casing, to paint these parts with aluminium paint, oil the dummy rings, and close all up again, keeping a heating stove in the engine room during the damp weather.

Speaking after a four years' experience of Parsons' marine steam turbine, from a superintendent engineer's point of view, the small amount of trouble and anxiety involved in the maintenance of this class of engine, as compared with the big paddlers, has astonished me. The turbine steamer gives no trouble whatever. She comes in and goes out, and nothing in the way of repairs is required throughout the season. Take this one item alone—the paddle-steamer *Empress Queen* of 10,000 indicated horsepower, which is still doing excellent work, is propelled by two wheels weighing together about 140 tons, the power being transmitted through two shafts 30 inches diameter. The *Ben-My-Chree* is propelled by three screw propellers of the total weight of 4½ tons, the shafts being 9 inches diameter. The disparity between the weights of the paddle wheels and screw propellers indicates to a very large extent the difference in the trouble and cost of upkeep of the two classes of engines.

In comparing turbine steamers with the ordinary reciprocating twin-screw channel steamers, there are two points in particular which may be noted in favor of the former:

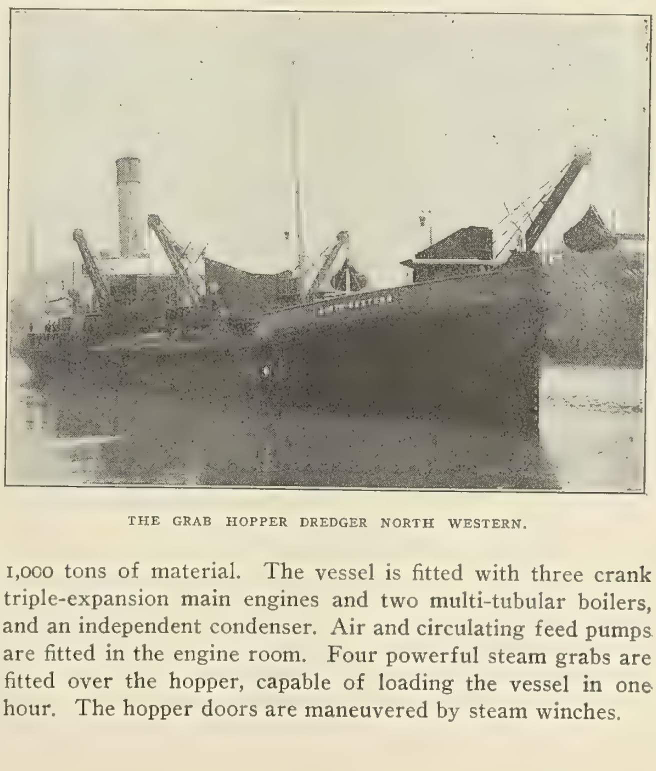
(1) Regularity of speed and economy of fuel in bad weather, the propellers being always well immersed and racing being quite unknown.

(2) Capacity for developing the maximum power at any time without undue strain. The steam turbine responds at once to the increased demand made upon it whenever an extra push is required, whereas when that time comes with a reciprocating engine you have abnormal bearing pressures and choking of steam passages, which absorb a lot of power and causes increased anxiety to those in charge.

Only those who have experienced the stress of managing reciprocating engines when pressed to the utmost limit can fully appreciate the contrast presented by the quiet, steady working of a turbine, and our best thanks are due to the Hon. C. A. Parsons for his worry-saving invention.

The Grab Hopper Dredger North Western.

One of the largest grab-bucket dredgers constructed has been built for the London & North Western Railway Company's service on the Mersey by Ferguson Bros., Port-Glasgow. The molded dimensions are: Length, 200 feet; breadth, 36 feet; depth, 16 feet 6 inches, and the hopper has a capacity for



THE GRAB HOPPER DREDGER NORTH WESTERN.

1,000 tons of material. The vessel is fitted with three crank triple-expansion main engines and two multi-tubular boilers, and an independent condenser. Air and circulating feed pumps are fitted in the engine room. Four powerful steam grabs are fitted over the hopper, capable of loading the vessel in one hour. The hopper doors are maneuvered by steam winches.

S. S. WAUKETA.

The accompanying plans of the steamship *Wauketa,* of the White Star Line, Detroit, Mich., represent a combination freight and passenger vessel for general service on the Detroit River, between Detroit and Port Huron. The vessel was designed by Prof. H. C. Sadler and Mr. Frank E. Kirby, the general arrangement representing the ideas of Mr. B. W. Parker, general manager of the line. Certain features are of interest.

In the first place, the trade is one where a number of stops at different places only a few miles apart are required, and at each place there is a certain amount of package freight to be loaded and unloaded. As this is apt to be somewhat bulky a large deck space is necessary, and this accounts for the somewhat full form of the main deck, and to a certain extent for the adoption of the screw instead of the paddle as a means of propulsion. The freight is loaded on to light trucks, which are wheeled bodily upon the vessel and deposited again at the required port. In this way the handling and time at the various ports is greatly reduced.

The principal dimensions are as follows: Length over all, 185 feet; length on keel, 175 feet; breadth, molded, 38 feet 4 inches; depth, 14 feet. The frame, beams, keelsons and stringers are of bulb-angle section, 5 inches by 2½ inches by 10 pounds, spaced 18 inches at the ends and 24 inches amidships. The shell plating is 10 pounds except the garboard and wale strakes, which are 13 pounds. There are four watertight bulkheads and one partial bulkhead aft of the engine room.

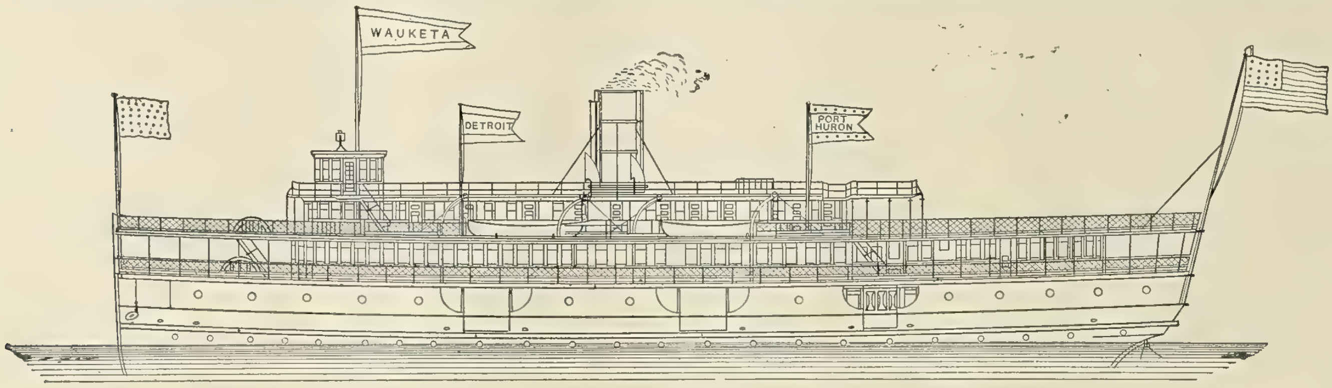
The contract for the steel part of the hull, engines and boilers was let to the Toledo Ship Building Company, and the vessel was delivered in ninety days after the signing of the contract. The actual working time was seventy-six days of nine hours each, and the time from the laying of the keel to the launching was twenty working days, or 180 hours.

The cabins and fittings are being installed by the White Star Line at their own shops.

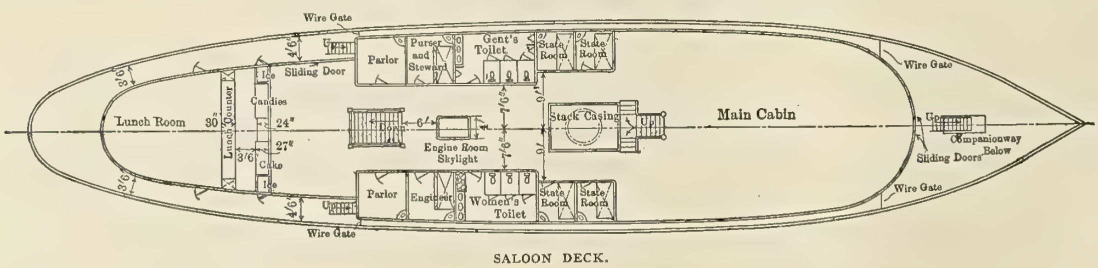
The machinery of the vessel consists of a triple-expansion engine, 17¼ inches, 27½ inches, 43 inches by 30 inches stroke, with the usual jet condenser and necessary bilge, fire and general service pumps. Steam is supplied from three Scotch boilers, natural draft, 10 feet 8 inches in diameter and 11 feet 6 inches long, and at a pressure of 180 pounds per square inch. The vessel will be lighted throughout with electricity and fitted with steam heat.

The general arrangement of the decks is as follows: On the lower deck forward are accommodations for the crew and galley. The whole of the forward part of the main deck to the after end of the engine casing is reserved for the cargo. The after end of this deck contains the main entrance, offices and bar. The saloon deck is reserved for passengers, and is fitted amidships with a few private staterooms. On this deck there is also a lunch room, with the usual lunch counter. Above this, on the boat deck, are situated the smoking room, the pilot house and the accommodations for the officers.

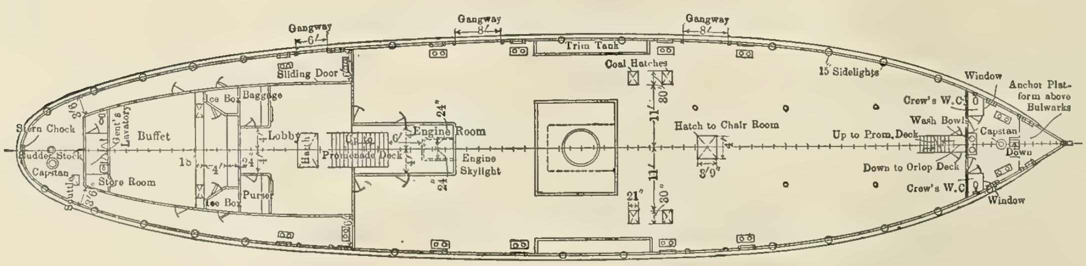
The model of the vessel was tested in the experimental tank at the University of Michigan, and experiments made until the best form for the given conditions was obtained.



OUTBOARD PROFILE OF S. S. WAUKETA.



SALOON DECK.



MAIN DECK.

SOME EXPERIMENTS WITH LIGHTENED BEAM BRACKETS.

BY R. EARLE ANDERSON.

In determining upon the details of certain torpedo-boat destroyers recently designed by the Bureau of Construction and Repair, it was realized that the necessary lightness of structure could be obtained only by giving to each item the most careful consideration, in order that the efficiency of each individual part of the structure, considered from the standpoint of weight and strength, might be made a maximum. Particularly was this the case with such structural members as beam and bulkhead brackets, the frequent recurrence of which throughout the hull made every pound saved in the type of the member a matter of great importance. The bureau had before it, of course, the details of all the torpedo boats and destroyers previously constructed for the United States Navy, and there were used, as a basis for improvement, many of the details of one of these older vessels that had justified in service the excellence of her design. The beam brackets on this vessel consisted of 15 inches by 15 inches by 10-pound lightened plates, without a flange, the type of which, together with the size and distribution of the lightening holes, is shown in Fig. 1. It fell to the writer to improve upon this bracket, the problem being to obtain the strongest and most rigid bracket possible upon the same weight.

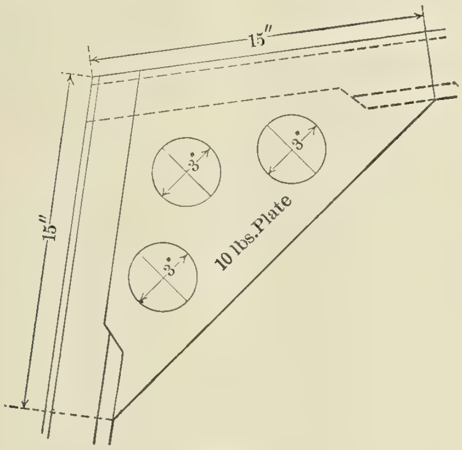


FIG. 1.

It was evident, of course, that a considerable increase in strength and rigidity could be obtained by flanging the edge of the bracket. This meant that if the alloted weight was not to be exceeded, the amount of metal removed by cutting lightening holes must be increased. It was evident also, that a greater area could be cut out by increasing the size of the lightening holes than by increasing their number. A hole 5 inches in diameter was about as large a circular hole as it was practicable to cut in a bracket of this size, however. The effect of such a hole is shown in Fig. 2. The load, that is to say the bending moment tending to open or close the angle between the deck beam and the frame bar, is transferred through the bracket from the rivets in the beam to those in the frame, and the stresses in traveling through the bracket must divide around the lightening hole in some such manner as is indicated in Fig. 2, leaving areas of metal practically unstressed and hence useless, the extent of which can only be guessed at, but which are approximately indicated by the shaded portions of the figure. To cut out these shaded portions would therefore leave the bracket quite as strong as though only the 5-inch hole were cut.

Fig. 3 shows how this theory was applied to obtain the largest practicable lightening hole, and at the same time one that could be cut without an excessive amount of labor. It will be seen that this hole can be cut by using a 5-inch die and a 3-inch die, leaving the small triangular portions to be cut away with a square punch. The amount of metal cut out by using this form of lightening hole made it possible to add to the bracket a tapered flange of the form shown in Fig. 3 without exceeding the allotted weight. In fact, had the bracket shown in Fig. 3 been made of 10-pound plate, as was that shown in Fig. 1, the weights of these two brackets would have been identical.

Some rough comparative tests were made at the bureau which proved the superiority of the flanged bracket with the lozenge-shaped lightening hole, and this form of bracket was

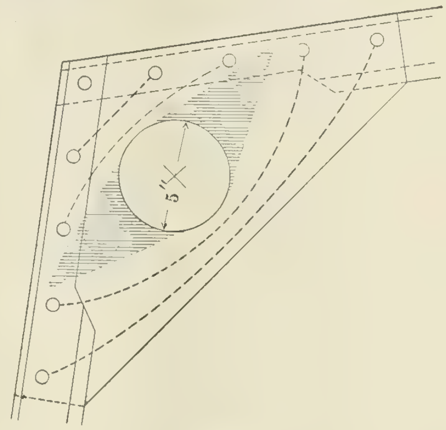


FIG. 2.

thereupon adopted for both deck beams and bulkhead stiffeners. These preliminary tests led the writer to believe that much could be learned about the behavior of parts of structures by tests on small specimens, and he determined upon performing at home a series of such tests on various forms of beam brackets, and the results of these tests confirmed the

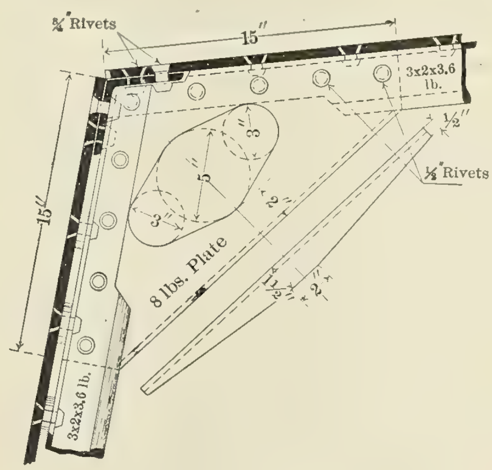


FIG. 3.

theory which led to the development of the bracket and the preliminary comparison made at the bureau, and brought about a reduction in the weight of the beam-bracket plating from 10 pounds to 8 pounds.

It is believed that a description of these tests and of the apparatus used will be not without interest, both because of the actual comparative and quantitative results obtained and because they show that it is possible to obtain much practical information from tests of small specimens, even with the crude apparatus which the home workshop affords.

The improvised machine used is shown in Figs. 4 and 5. It was built upon the back of a drawing board that was provided with strong oak cleats. A piece of heavy sheet metal (*A*), secured to one of these cleats represented the frame of the ship, while a steel bar (*B*), 2 by 3/16 inch in section, represented the deck beam, the bracket being bolted to these two members and forming the connection between them, except for the bolt (*G*), the function of which will be explained later. To increase the leverage, a second flat bar (*C*) was employed, with a knife-edge fulcrum at *D*, and a link with two knife edges at *E*. The load consisted of two groups of lead batten weights (only one of which is shown in the figure), tied together with wire and suspended on the knife edge *F*. The groups of batten weights weighed, respectively, 19¼ pounds and 19⅛ pounds. The total weight available was thus 38⅜ pounds, to the moment of which was to be added that due to the levers themselves. The total bending moment which could be brought upon the bracket was thus considerable, and in some of the tests was increased by shortening the distance between the knife edges *D* and *E* to about half that shown in Fig. 4. These knife edges consisted of short pieces of steel cut from a ¼-inch square bar and riveted into side pieces of heavy sheet steel. They formed a very simple and satisfactory part of the apparatus and were easily made.

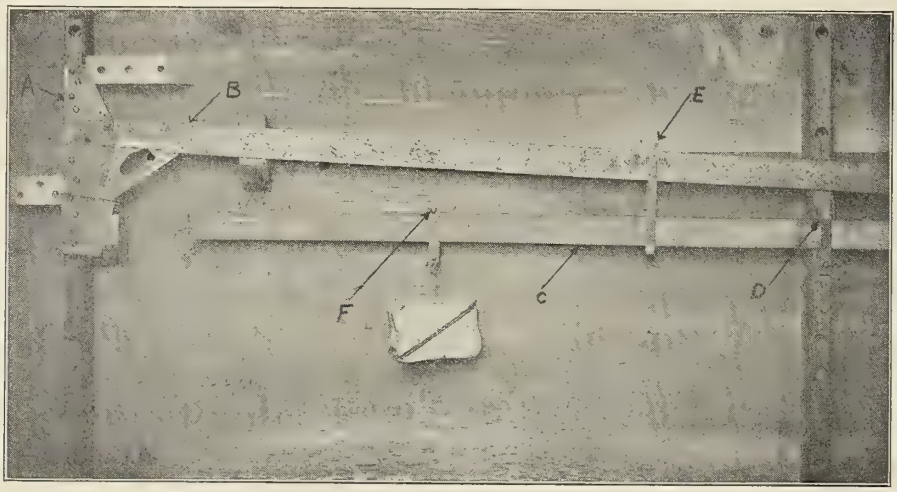


FIG. 4.—TESTING APPARATUS.

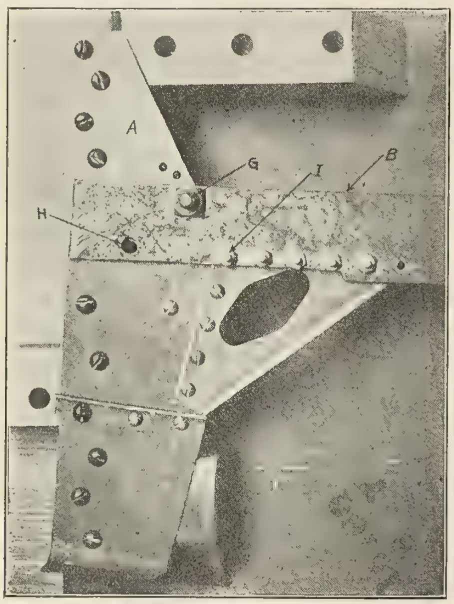


FIG. 5.—DETAILS OF CONNECTION.

As actually fitted on the ship, the entire connection between the frame and the deck beam does not consist of the bracket only. The deck stringer is, of course, attached to the beam, and the sheer strake to the frame, these two plates being in turn connected to each other by the stringer angle, the riveting of which adds materially to the beam-to-frame connection, and these cannot be neglected in any consideration of the strength of beam brackets. It was necessary, therefore, to so arrange the testing machine as to account for the effect of the stringer angle.

It appeared proper to take account of the rivets in this connection for the extent of one frame space, and as their aggregate area was large in comparison with the area of the rivets connecting the bracket to the beam, it was not practicable to represent them in the testing machine by a bolt of corresponding size and in corresponding location. Accordingly a smaller bolt was used (⅜ inch), and it was placed in such a location that the "neutral axis" of the system of bolts was in a location corresponding approximately to the location of the "neutral axis" of the system of rivets in the actual case. This bolt was originally put at *H*, but after a portion of the tests had been made, it was decided that it would be more nearly correct to locate it at *G*, and this was accordingly done. The comparative results given below were obtained with the "neutral axis bolt" at *H*, while the formulas are derived from the results obtained with this bolt at *G*. In order that the bolts *G* and *I* might not of themselves support the lever and so relieve the bracket, the bolt *I* was put through the bracket and the bar *B* only, the plate *A* being cut out around it.

The test specimens represented the full size brackets to a scale of 3 inches to the foot; that is, they were one-fourth actual size. They were made of sheet steel 1/32 inch thick, corresponding to 5-pound plate. The different types of bracket tested are shown in Figs. 6 and 7. Brackets 1, 4 and 5 all have the same outline, as have also brackets 6, 7 and 10, except that these latter are flanged. Bracket No. 1 is without lightening holes; No. 2 is lightened by ¾-inch holes closely spaced; No. 4 is the same as that shown in Fig. 1; No. 5 is similar to No. 4, but has one 5-inch and two 3-inch lightening holes. These dimensions refer, of course, to the full size bracket, not to the test specimen. Bracket No. 3 is a type which was used on some of the earlier torpedo vessels. It has a flange of parallel width. It forms a brace across from beam to frame, but is hardly a true bracket connection. Nos. 6 and 7 are the same as Fig. 3, except that No. 6 is solid.

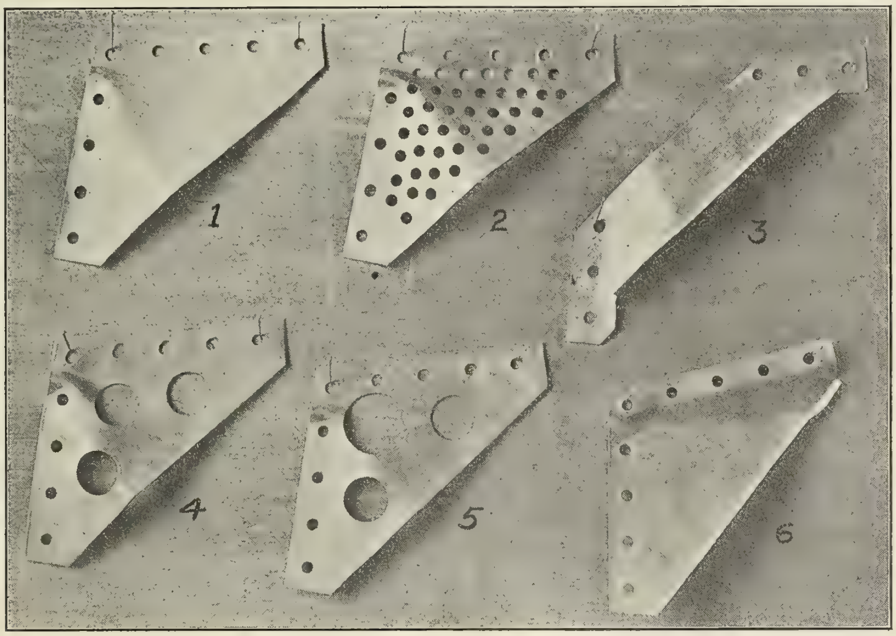


FIG. 6.

Bracket No. 9 is a special type, based on No. 7, but having the extremities of the flanged portion bent down flat and continued to the center line of the bolts, with a view to avoiding the sudden discontinuity of stiffness that occurs in No. 7 where the flange ends.

The results of the tests of twenty-four specimens of types 1, 2, 3, 4, 5, 6, 7 and 9 are shown in the following table.

RESULTS OF TESTS.—SERIES 1.

Type No.	Moment at Failure (in Pounds).	Average Moment at Failure (in Pounds).	Variation Percent.	Weight in Ounces.	Moment Divided by Weight.	Comparative Strength.
1	1,700 1,857 1,395 1,672	1,656	16	1.3	1,274	1.00
2	1,395 1,313 1,337	1,348	3½	1.1	1,225	0.96
3	1,925 1,967 1,823	1,905	4	1.2	1,588	1.25
4	1,407 1,097 1,980	1,495	32½	1.2	1,246	0.96
5	1,305 1,563 1,540	1,469	11	1.1	1,336	1.05
6	2,763 3,020 2,450	2,744	10½	1.5	1,829	1.43
7	2,334 2,334 2,773 2,438	2,470	12	1.2	2,058	1.62
9	3,166	3,166	..	1.2	2,638	2.07

Column 1 refers to the different types as designated in Figs. 6 and 7. Column 2 shows the bending moment that caused failure in the case of each specimen. Column 3 shows the average ultimate bending moment for each type. Column 4 shows the maximum percent of variation of the individual ultimate moments from the average ultimate moment for each type respectively. Column 5 shows the average weight of each type. There is given also for each type a factor obtained by dividing the bending moment at failure by the weight of the specimen. This factor does not, of course, give a true basis of comparison, but as all of the specimens were of nearly the same general dimensions, it provides a reasonably fair means of eliminating the differences in weight and judging the relative value of the different types. Accordingly the last column gives the comparative strength as determined by the moment-weight factor, taking type No. 1 as unity.

Certain important deductions may be made from this table, some of which are of general application to forms of structure other than brackets. A comparison of the strength factors in the last column shows that the strength of types 1, 2, 4 and 5; that is, the brackets without flanges is almost exactly in proportion to their respective weights; that is, in whatever proportion the bracket is lightened, whether by large holes or small, the strength is reduced in the same proportion. In the case of the flanged types 6 and 7, however, the lightening hole makes almost no difference. The average ultimate bending moment is slightly higher for 6 than for 7, but the ranges of values for individual specimens overlap, and the comparative strength with the weight factor eliminated is considerably higher for the lightened bracket than for the solid one. Bracket No. 9, as was expected, is the most efficient of all, but is, unfortunately, not practicable for structural work. Bracket No. 3, while stronger than the unflanged types, shows the lack of a throat connection and is consequently inefficient as compared with type 7, although preferable to 1, 2, 4 and 5.

The column of percent of variation is not without interest. With the exception of type 4, all the variations are within the limits usually obtained for specimens of this general class in thoroughly equipped testing laboratories. The home-made testing machine and the one-fourth size sheet-metal specimens need no defense in view of these results. With respect to the excessive variation in the case of type 4, it simply shows the general unreliability of an excessively lightened, unflanged plate bracket. That the results for type 5 do not show as great variation, may be, and probably is, due to accident.

Aside from the lack of a flange, the trouble with types 4 and 5 is, that there is a great localized weakness near the edge of the bracket. If an unflanged bracket is to be used, type 2 is certainly preferable to the large hole type for this reason.

What the table does not show is the behavior of the different types under stress and before failure. According to the table, the flanged bracket, type 7, is 62 percent stronger, weight for weight, than bracket No. 1, and 70 percent stronger than the unflanged bracket of equal weight, No. 4. Actually, however, and for the practical purpose for which the brackets are intended, that is for rigidly connecting two structural

members so that their full strength may be developed, superiority of the flanged bracket over the unflanged one is vastly greater than the figures show. For, while the flanged brackets showed little or no lateral deflection until the breaking load was approached, the unflanged brackets deflected laterally to a decidedly appreciable extent under the least load that could be applied, namely, that of the lever bar *"B"* only, this deflection increasing greatly as the load was increased. In fact one of the most remarkable things noted during these tests was the extent to which these unflanged brackets would deflect laterally before total collapse.

It is thus evident that within the limits of a safe working load, the flanged brackets can be depended on for absolute rigidity, while the unflanged plates are entirely worthless from this standpoint and cannot be depended upon to add anything to the resistance of the vessel against wracking.

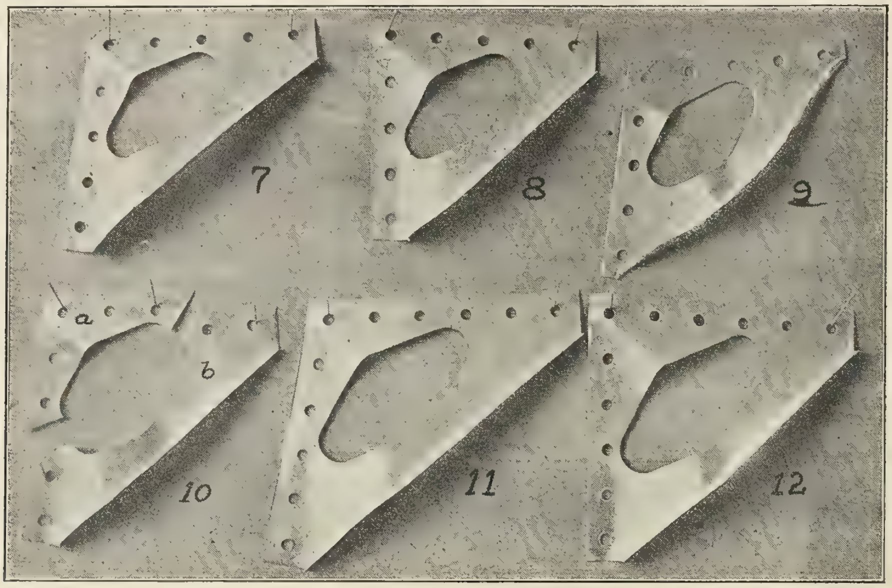


FIG. 7.

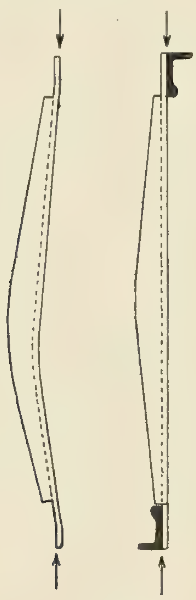


FIG. 8.

As regards the tapered forms of the flange, the experiments showed that its proportions were practically correct. Failure always occurred in the tapered portion of the flange, never nearer to its end than in the case of the specimens shown in the photographs; and as the failure was sometimes near the middle, sometimes near the end, and at about every point between, a fact also well shown by the photographs, it is a fair inference that the amount of taper given to the flange is about correct. Although the writer has considered the possibility of determining the proportions of the flange by rational means, no method for doing so has presented itself which would seem to be justified by the results of the experiments.

We pass now to a consideration of the strength of the taper-flanged, lozenge-lightened bracket from the theoretical standpoint, and the determination of a practical working formula, based on these experiments for use in proportioning a bracket to suit any given case.

It appears that the interpretation of the results of the tests, and the determination of a rational method of design should be based upon the following principles:

(a) The load in the rivets varies directly as the distance from a point which corresponds to the neutral axis of a beam.

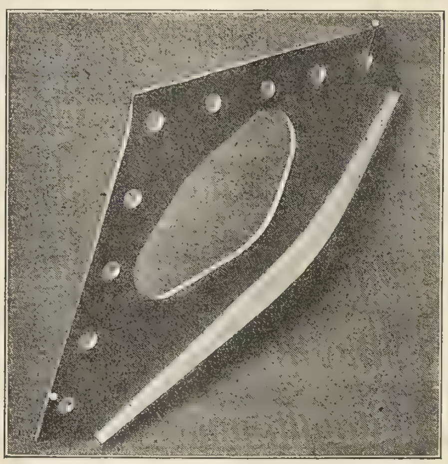


FIG. 9.—TAPER FLANGED BRACKET.

(b) In determining the load in the bracket rivets, the rivets connecting the stringer plate to the stringer angle for the extent of one frame space should be considered as forming part of the connection.

(c) The load from the two (or three) outermost rivets is transmitted through the flanged portion of the bracket, that

is the portion outside the lightening hole, and this portion of the bracket acts as a column or strut.

(d) The load from the remainder of the rivets is transmitted through the throat portion of the bracket, and this load being small, as compared with that through the outer portion, the strength of the outer portion determines the strength of the bracket.

As it is usual to base the column formulas upon the value of $\frac{l}{r}$, that is the column length divided by the radius of gyration of the section, a second series of tests was made with specimens as shown in Fig. 7, brackets Nos. 7, 8, 11 and 12. Type No. 7 has already been described. No. 8 is similar to No. 7, but the throat angle is 90 degrees. No. 11 is made of the same gage steel as No. 7, and has the same throat angle, depth of flange, etc., but is sufficiently large to take one additional bolt in each connection. No. 12 is similar to No. 11, but the throat angle is 90 degrees. For this second series, three specimens were tested of each type, except No. 7, of which there were four. All of these brackets had the same

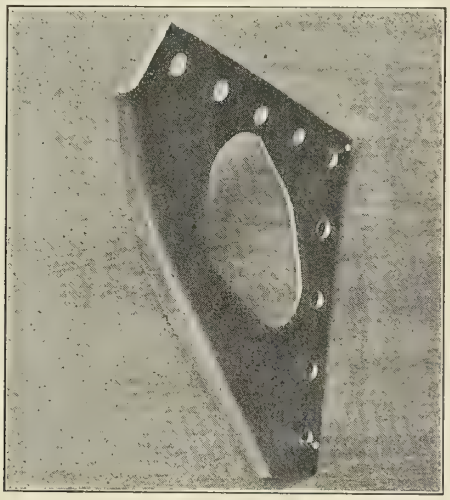


FIG. 10.

value of r for the strut portion, since the depth of the flange was the same in all cases and the lightening hole was the same distance from the edge, but there were four values of l. While a greater range of values of $\frac{l}{r}$ would have been desirable, this was about the best that could be done with the facilities available. The bolt for controlling the position of the neutral axis was, as previously explained, shifted to *G*. Fig. 5.

Calculations were now made to determine what would be, for any moment *M*, the load transmitted to the outer or strut portion of the bracket. The details of these calculations are similar to those which are to be described later for the case of a full size bracket and need not be given here. They resulted as follows, the load being in pounds when the moment is in inch-pounds:

Bracket No. 7, load $= 0.188M$
" " 8, load $= 0.188M$
" " 11, load $= 0.150M$
" " 12, load $= 0.150M$

These are the loads in the two outer bolts in each case. For bracket No. 7 the total load in the remaining three bolts was calculated, and as a rough check on the theory of the distribution of the loads in the rivets, three specimens were cut as indicated by No. 10, *a* and *b*, Fig. 7, and the throat and strut portions were broken separately with the following results: Calculated ratio

$$\frac{\text{strut}}{\text{throat}} = 2.71$$

Average of three tests

$$\frac{\text{strut}}{\text{throat}} = 2.24$$

Although the conditions in the intact bracket were not, of course, really reproduced in the "*a*" and "*b*" portions when tested separately, the results indicate that the theory of the distribution of the load in the rivets is not widely at variance with the facts.

Before giving the tabulated results of the tests on brackets 7, 8, 11 and 12, one more explanation is necessary. As will be seen in Fig. 8, the load on the strut portion of the bracket is not central, but eccentric, giving rise to a bending moment, the stress due to which must be allowed for and included in the real ultimate breaking stress. As the amount of the eccentricity and the dimensions of the cross-section are the same for all four types, the unit stress in the extreme fiber, due to the eccentricity of the load, bears for all four types the same proportion to the applied load and is shown by calculation to be 20.5 times the total direct load when the latter is taken in pounds, and the stress due to the bending moment is expressed in pounds per square inch.

The following table shows the actual results of this series of tests and the calculated results derived from them. The values of l are taken as the respective lengths of the flange, which, being about the same as the length between the outermost rivets, is, probably to all intents and purposes, the true column length, and is, at all events, the most convenient for practical use.

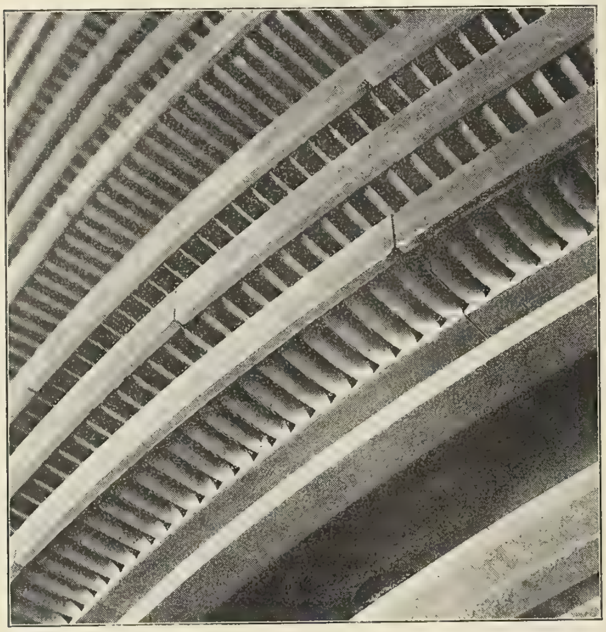
(*To be Concluded.*)

TABLE OF RESULTS.—SERIES 2.

Type No.	l Inches.	r Inch.	$\frac{l}{r}$	Area of Section Square Inch.	Actual Ultimate Moments in Pounds.	Average Ultimate Moments in Pounds.	Percent Variation.	Average Load, Pounds.	Unit Load Pounds per Square Inch.	Unit Stress Due to Eccentricity (Compression).	Total Unit Load, Pounds per Square Inch.
7	5.	0.116	43	0.0272	1,713 1,455 1,740 1,470	1,577	11.3	297	10,900	6,100	17,000
8	4.3	0.116	37	0.0272	2,125 1,910 1,885	1,973	7.7	371	13,650	7,400	21,050
11	6.25	0.116	54	0.0272	1,440 1,785 1,485	1,570	13.7	235	8,650	4,840	13,490
12	5.5	0.116	47.5	0.0272	1,542 1,355 1,300	1,399	10.2	209	7,700	4,290	11,990

REPAIRS TO THE TURBINES OF THE U. S. SCOUT CRUISER SALEM.

The United States scout cruiser *Salem* has been sent to the builders, the Fore River Shipbuilding Company, for an examination of the main propelling turbines, which are of the Curtis marine type. During the recent competitive trials the starboard turbine ran considerably slower than the port, with the same steam supply, thus indicating that some internal derangement had occurred, although there was no difficulty in its operation.



BUCKETS IN FRONT ROW BENT OVER, COMPLETELY CLOSING STEAM PASSAGE.

When opened up it was discovered that some foreign body had become caught in the fifth stage between the nozzles and first row of buckets. It had bent over the edges of the buckets so as to completely prevent any steam passing through them, and had broken about one-quarter of the nozzle division plates. The foreign body which caused this has not yet been found, but a loose 5/8-inch nut was found in the fifth stage, lying in the bottom of the casing, which did not become caught in the moving parts.

Examination of the port turbine disclosed a service bolt, 2½ inches long, which was not a part of the machine, lying in the first stage against the nozzle openings leading to the second stage. The damage done here was comparatively slight.

The rotors of both machines were also found to have moved axially, so as to allow the moving buckets to rub against the stationary guide blades, with the result that in the first and second stages, where the axial clearances are least, the guide blades were worn on the edges, but no blade stripping occurred. As in these stages the guide blades only cover a small part of the circumference, practically all the wear occurred on them and very little on the moving buckets. All blading was found to be entirely free from any erosion due to the action of the steam, and the surfaces were as smooth as when first installed.

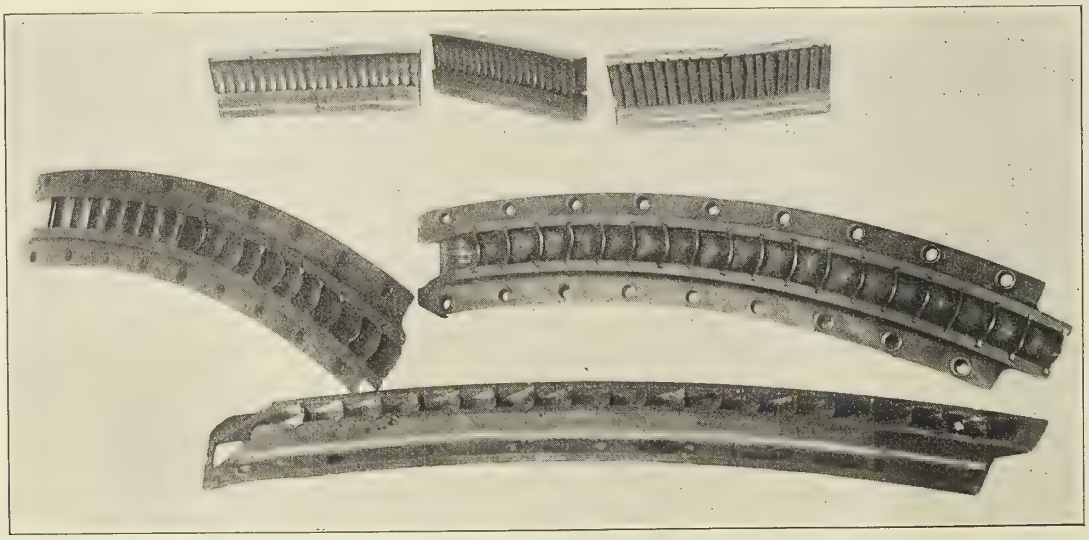
This shows that the Curtis type of construction has a remarkable ability to withstand abuse and still remain in operative condition; as even in this condition the vessel made 24½ knots for twenty-four hours, and for the first eight hours made 25 knots, while the contract speed required 24 knots for four hours. Also the operation of the turbine was perfect, and except for the drop in revolutions it would not have been known that any internal damage had occurred.

The damage is being repaired, and is expected to be finished in thirty days from the vessel's arrival at the builder's yard.

THE LAPLAND.

The Red Star Line has recently placed on its New York-Dover-Antwerp service the new twin-screw steamship *Lapland*, of 18,694 gross tons, built by Messrs. Harland & Wolff, of Belfast, Ireland. The vessel is 620 feet long over all with a breadth of 70 feet and a depth from the keel to the top of the shelter-deck beams of 50 feet. With a displacement of 30,500 tons, the load draft is 35 feet 3 inches. Quadruple expansion engines are installed, with a total indicated horsepower of 13,000. Accommodations are provided for 394 first class, 352 second class and 1,790 third class passengers.

The *Lapland* was built in accordance with the requirements of the British Board of Trade and the American and Belgian laws for passenger vessels. The hull is divided into eleven watertight compartments; a centerline bulkhead being provided for additional safety. The double bottom extends throughout the entire length of the ship, and is made excep-



DAMAGED BLADING OF THE SALEM'S TURBINE.

THE NEW RED STAR LINER LAPLAND.

tionally rigid in the machinery space. There are nine decks and six cargo holds. The coal bunkers are arranged so that the ship can be coaled from either side.

All the first class accommodations are situated in the superstructure amidships. On the upper promenade deck are situated the lounge, the reading and writing room, and the smoking room. The lounge is decorated in the style of the early Georgian period, with walls and ceiling paneled in oak. At the after end is an ingle nook with a handsome fireplace. Mahogany furniture and large windows upon which are appropriately painted scenes in various Belgian and American cities add much to the attractiveness of the room. Card tables and writing desks are also provided. The reading and writing room is situated amidships and is decorated in white. As in the lounge, there is an ingle nook with an attractively designed fireplace. In the smoking room special attention has been paid, not only to decoration and comfortable furnishing, but also to the ventilation. The walls are of paneled oak, and upon them are displayed views of various Belgian, American and English cities. The ceiling is also set in panels, but there is a large colored-glass dome in the center bearing in medallions the twelve signs of the Zodiac. Located aft, and adjacent to the smoking room, is a veranda café, finished in enameled white and furnished with teakwood chairs and small tables, arranged after the style of out-door cafés on the Continent.

Other special features located on the upper promenade deck are a photographic dark room and a small shop, where a great variety of articles necessary for the comfort of the passengers can be purchased. An electric elevator is installed to convey passengers from the upper promenade deck immediately to the entrance of the dining saloon or to the various stateroom decks.

CORNER OF THE LAPLAND'S DRAWING ROOM.

The first class dining saloon extends the entire width of the vessel, a distance of 70 feet, and at the sides large windows are arranged in pairs to insure good light and adequate ventilation. The room is paneled in white and old gold, the furniture being of oak. Small tables, arranged in the popular restaurant style, are provided. At the forward end there are two sideboards of carved oak, with a piano of the same wood between them, while overhead a small balcony provides a convenient place for the ship's orchestra. In the center of the saloon is a large dome, with a surrounding balustrade.

The staterooms are arranged in a variety of ways, from suites de luxe, consisting of sitting room, bedroom, bath and toilet, to single-berth rooms. Where cabins are designed for two or more passengers, all the upper berths are built in the Pullman folding style. A large amount of deck space is available for the passengers, particularly on the sun, upper promenade and promenade decks. The upper promenade deck is fitted with wind screens containing windows, so that the deck may be entirely inclosed in bad weather.

THE LOUNGE ON THE LAPLAND.

The second class accommodations have been given careful attention, the dining saloon, which extends the full width of the vessel, having a seating capacity of 220 persons. It is finished in white and gold, with mahogany furniture, with a handsome sideboard and piano at one end. The second class library is a large room, paneled in sycamore, with mahogany furniture. In the smoking room the walls and furniture are of oak, while a large skylight with embossed glass and large windows at the sides of the room provide ample light and ventilation.

The third class accommodations include two, four and six-berth rooms, together with a large social hall on the shelter deck.

Change of Address.

On May 1, 1909, the address of the North-East Coast Institution of Engineers & Shipbuilders was changed to Bolbec Hall, Westgate Road, Newcastle-upon-Tyne.

MAST AND DERRICK MOUNTINGS.

COALING AND SAMSON POST DERRICKS.

Fig. 1 shows a Samson post and coaling derrick 25 feet long, 9 inches diameter at the center and 6 inches at the ends. The forks of the shod are 31 inches long from the center of the pin. At the heel end the forks are 3¾ inches broad by ⅝ inch thick, tapering to 2½ inches by 9/16 inch at the inner end. Three ¾-inch clinched bolts are driven through the derrick and clinched on the forks; two bands are also fitted, the aftermost one is 3¼ inches broad by 9/16 inch thick, the inner one 2¾ inches broad by 9/16 inch thick. The aftermost band is 9½ inches from the center of the pin, the inner band is 27 inches from the center of the pin. The snug through which the pin passes is 4 inches deep by 1⅞ inches thick. The pin is turned steel 1¾ inches diameter.

The gooseneck sole is 16 inches long by 11 inches broad and ⅞ inch thick, arranged to take six ⅞ inch rivets. From the sole extend two jaws; the upper is 3¼ inches deep by 5 inches broad, and the lower 2¼ inches deep by 5 inches broad. The 3½-inch space in between the jaws is used for fitting the link to take the leading block to the winches, etc. The link at the attachment to the leading block is 1¼ inches diameter and must be long enough to allow the shackle of the leading block to ship and unship easily. Through the body of the link a hole 2⅜ inches diameter is bored to allow the spindle to pass through easily, and thus allow the link to move to follow the lead block as it moves to its work. The jaws for the heel fitting are 1¼ inches thick, with a 2-inch space between. The spindle as it passes through the upper jaw of the gooseneck plate is 3 inches diameter (for thickness of upper jaw only), for the remainder of its length it is 2¼ inches diameter. At the underside of the lower jaw a split forelock pin is fitted to prevent lifting when loads are applied. The center of derrick pin is 4 inches above the upper jaw of the gooseneck plate, and is 7 inches from the sole. The type of gooseneck

plate shown here is for fitting against a casing or bulkhead, but can be curved to suit a mast or Samson post.

The head-fitting band is 4 inches broad by ¾ inch thick, with a snug on the upper side 1⅜ inches thick, suitable for taking a 1¼-inch shackle. To the shackle is fitted a 1-inch link to take a ⅞-inch chain as a topping lift. If the ⅞-inch chain does not find favor with ship owners, a 3-inch S. W. rope may be substituted, the working load of each being about 8¼ tons. A ¾-inch eye is fitted on each side of the band to take guys. A 1¼-inch eye is fitted on the bottom of the band to take a 1¼-inch link; to this link is fitted the shackle of the gyn block. At the head of the derrick a plate is fitted at top and bottom and end, with two snugs to prevent the band moving when a load is applied.

Attention should always be paid to see that snugs are fitted at bands with screws or clinched bolts; when care is taken about the fitting of those small details it saves much time and trouble afterwards. The band is usually fitted 1 foot from the head of the derrick.

The hoop for the coaling derrick is 3½ inches broad by ⅝ inch thick, and has two snugs set at angles on the upper side to take topping lift guys. With the style shown here, the derrick heel is supposed to be fitted slightly above the deck, with topping lifts fitted to the casings. On the lower edge of the band is fitted a 1⅛-inch wrought eye, with a suitable link to take the gyn block.

5-TON DERRICKS.

Fig. 2 shows a 5-ton derrick 46 feet long, 13 inches diameter at the center and 11 inches at the ends. The derrick shows bands for taking two gyn blocks. The upper band is 9 inches from the head of the derrick, and the distance between the bands may be anything from 4 feet 6 inches to 6 feet.

The forks of the shod are 3 feet 2 inches in length from the center of the pin. The forks at the end of the derrick are 4 inches broad by ⅝ inch thick; at the inner end the breadth

spindle is 3 inches, and the overall diameter of the crown is 9¼ inches. The socket is fitted to the mast table with six 1-inch rivets or bolts. The thickness of the spigot is made to suit the thickness of plating on the derrick table.

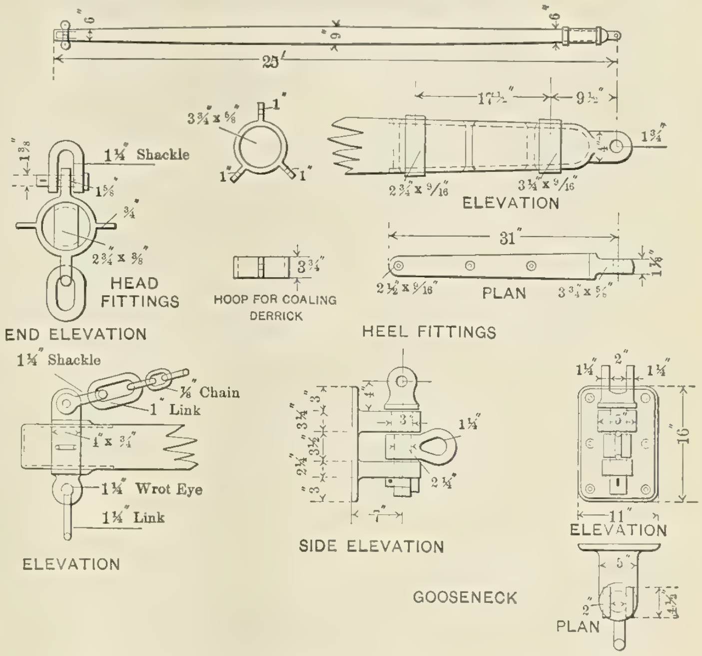


FIG. 1.

The jaws of the goosenecks are 1¼ inches thick, with a distance of 2⅛ inches between, suitable for the thickness of the shod snug. The flat of the jaws is 4½ inches broad to take a pin 1¾ inches diameter. The neck of the gooseneck is 6 inches diameter, a dimension which gives plenty of area for resting on the socket. The spindle is 3 inches diameter

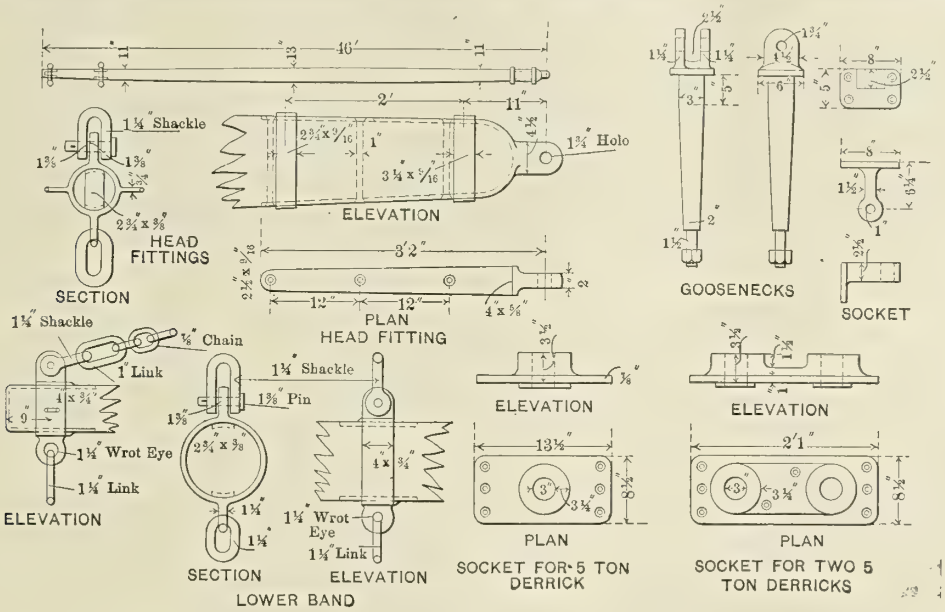


FIG. 2.

is 2 inches, and the thickness 9/16 inch. Through the shod three 1-inch bolts are driven and clinched, and spaced 12 inches apart. A band 3¼ by 9/16 inch is fitted 11 inches from the heel, and a second band 2¾ inches by 9/16 inch is fitted 2 feet 11 inches from the heel. The snug at the end of the shod through which the pin passes is 4½ inches deep by 2 inches thick. The pin is of steel 1¾ inches diameter.

The derrick sockets are castings, with a sole 13½ inches long by 8½ inches broad, with a base ⅞ inch thick; from base to crown it is 3½ inches deep. The diameter of the

for a length of 5 inches, when it begins to taper to 2 inches till it reaches the upper edge of the socket on the center plate of the mast platform, when it becomes 1½ inches diameter, retaining this diameter to the end. The portion on the underside of the socket on the center plate of the mast platform is screwed and a nut fitted. Through the nut and spindle a hole is bored and a tapered pin fitted to prevent the nut being lost. The length of the gooseneck is entirely dependent upon the depth of the center plate of the mast platform.

The sole of the socket is 8 inches broad by 5 inches deep by

¾ inch thick, and it is arranged to take four rivets. The arm of the socket is 2½ inches deep by 1½ inches broad, and 1 inch of metal is left all round the boss. From the edge of the plate to the center of the boss, the distance is given as 6¼ inches; this dimension is only a relative one, as the centers of derricks before and abaft the web plate of the mast platform determine this.

The upper and lower bands are 4 inches broad by ¾ inch thick, with 1⅜-inch snugs on top for taking a 1¼-inch shackle, with a 1-inch link and ⅞-inch chain. A 1¼-inch wrought eye is worked on the lower edge, with 1¼-inch links to take gyn blocks. Three-quarter-inch eyes for guys are fitted on the sides of the upper band only. To each band the usual snug plates are fitted, to prevent the bands shifting when the loads are applied. The snug plates are 2¾ inches by ⅜ inch.

A sketch is shown here of two derricks fitted in one socket. The socket is a casting 2 feet 1 inch long, 8½ inches broad, long, 9 inches broad and 1 inch thick. The crown is 3½ inches above the base and is 8 inches broad. Through the crown a hole is bored to suit the spindle of the gooseneck; this leaves 2 inches of metal all round the crown. A spigot is arranged for on the underside of the sole to suit the thickness of the mast table plating. The socket is secured to the mast table plating by six 1⅛-inch rivets.

The jaws of the goosenecks are 1⅛ inches thick by 5 inches broad, with the center of the 2½-inch diameter pin 5 inches above the throat of the jaws; this leaves the center of the derrick pin 8½ inches above the mast table. The spindle is 4 inches diameter for a distance of 5 inches below the throat; then it tapers to 2½ inches; the length of this taper is determined by the depth of the mast table center plate. When the spindle reaches the socket on the web of the mast platform it is 2 inches parallel, and a portion below the socket is screwed, and a nut is fitted with a hole bored through the nut and

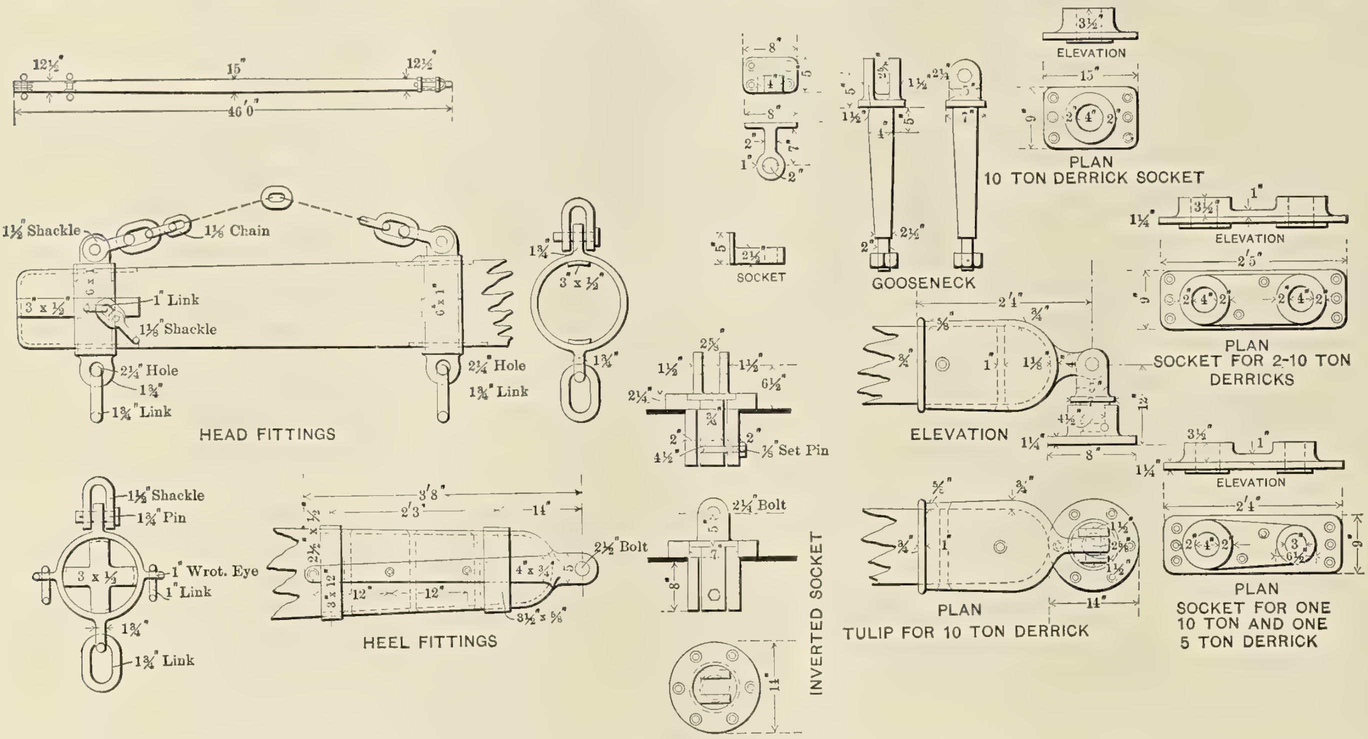


FIG. 3.

with a sole 1 inch thick. The top of the crown is 3½ inches above the base plate; the diameter of the crown is 9¼ inches overall; between crowns is a raised portion 1 inch deep. The socket is fixed in place with eight 1⅛-inch rivets or bolts. The distance between the two centers of the derricks must be regulated by the distance of the derrick heels on each side of the web plate of the mast platform.

The heel fittings are drawn for a derrick fitted on a mast platform.

10-TON CARGO DERRICKS.

Fig. 3 shows a 10-ton cargo derrick 46 feet long, 15 inches diameter at the center, 12½ inches diameter at the ends, with double bands arranged to take purchase or gyns.

The heel fitting is of the four-forked shod type. The length of the forks is 3 feet 8 inches from the center of the pin; the forks are 4 inches broad by ¾ inch thick at the heel and 2½ inches broad by ½ inch thick at the inner end. They are connected together through the derrick by six 1-inch clinched bolts, spaced 12 inches apart. A band 3½ inches by ⅝ inch is fitted 14 inches from the pin; a lighter band 3 inches by ½ inch is fitted at a distance of 3 feet 5 inches from the center of the pin. The bolt snug is 5 inches deep by 2½ inches broad, and takes a 2½-inch bolt.

The single-derrick socket is a casting with a sole 15 inches spindle to prevent the spindle from lifting when loads are applied.

The sole of the gooseneck socket is 8 inches long by 5 inches broad by ¾ inch thick, and is bored to take four rivets. The socket arm is 2½ inches deep by 2 inches broad; 1 inch of metal is left clear all round the boss. A distance of 7 inches is given from the sole to the center of the boss, but this is only relative, as this distance must be made to suit the distance of the derrick heel from the center plate of the mast table.

The tulip and socket shows an alternative heel fitting for derricks. The tulip is a casting 2 feet 4 inches long from the center of the pin, and is of the following thicknesses: At the derrick heel 1⅛ inches; 12 inches from the center of the pin, ¾ inch; at the end of the tulip, ⅝ inch. A ¾-inch rib is arranged for at the end. Two 1-inch countersunk bolts are driven through the derrick and tulip. The pin snug is 5 inches at the deepest part, 4 inches at the shallowest, and 2½ inches broad. A 2½-inch bolt passes through the snug.

The gooseneck jaws are 1½ inches thick by 5 inches broad, with a distance of 2⅝ inches between them. The spindle is 4½ inches diameter, with a 1-inch groove all round. A 1-inch pin is fitted through the socket and spindle to prevent the derrick lifting, and is securely fastened to the socket with

keep-chains. The fitting of the groove in the spindle allows the derrick to move freely to its work. The socket may be a casting or forging, and is of the following dimensions: Sole, 14 inches diameter, 1 inch thick; crown, 8 inches broad, 1¾ inches metal all around the spindle, 7 inches high from the bottom of the hole; six 1-inch rivets are provided for in sole.

A sketch is also shown of the well-known inverted socket. The sketch, however, is self-explanatory.

THE MINNEWASKA.

The Atlantic Transport Line has recently placed in service a new passenger and freight steamship of 14,500 tons. This ship, which is named the *Minnewaska,* was built by Harland & Wolff, of Belfast, and is a sister ship to the other four 600-foot vessels of the Atlantic Transport Line, two of which were built by Harland & Wolff, and the other two in the United States.

The principal dimensions of the *Minnewaska* are: Length, 615 feet 3 inches; beam, 65 feet 3½ inches; molded depth, 44 feet; load draft, 33 feet 2 inches; displacement, 26,530 tons; horsepcwer, 11,000; speed, 16 knots.

The hull is divided by bulkheads into eleven watertight compartments. There are five steel decks throughout, and a double bottom extending from the forward collision bulkhead to the stern-tube bulkhead. The tanks have a total capacity of 4,300 tons, and the coal bunkers a capacity of 1,890 tons. The passenger accommodations are placed amidships in the superstructure, leaving the entire deck forward and aft free for handling cargo. There are nine cargo hatches, five forward and four aft. The cargo booms are swung from four pole masts and two derrick poles. There are four booms on each mast and two on each derrick pole. Each boom is served by a separate steam winch.

The ship is propelled by two sets of quadruple-expansion engines, each having four cylinders. The sequence of cylinders is from forward aft—high pressure, second intermediate; low pressure, first intermediate. Piston valves are fitted to all cylinders except the low pressure, which has a flat, double-ported slide valve. Each cylinder is a separate casting, and is supported by cast iron box columns, the condenser being cast in the outboard columns. The bed-plates are also cast iron and of box section. The diameters of the cylinders are 30, 43, 63 and 89 inches, with a common stroke of 60 inches. At a speed of 75 revolutions per minute the indicated horsepower is estimated as 11,000.

Steam is furnished at a working pressure of 215 pounds per square inch by four double-ended and four single-ended Scotch boilers, each 14 feet 5 inches in diameter. The double-ended boilers are 19 feet 10 inches long, and each has six corrugated furnaces, 40 11/16 inches inside diameter. The single-ended boilers are 11 feet long, and each has three furnaces, 40 11/16 inches inside diameter. The total grate surface is about 642 square feet, and the total heating surface 26,336 square feet, making a ratio of heating surface to grate surface of 41.02. Howden's system of forced draft is installed.

The propellers are each three-bladed, 18 feet 6 inches in diameter, 23 feet 6 inches pitch. They have cast iron bosses and bronze blades. The propeller shafting is 18¼ inches in diameter, the intermediate shafting 17 inches in diameter, and the crank shafting 18 inches in diameter; all shafting being of mild ingot steel.

The air, bilge and sanitary pumps are driven by levers from the first intermediate cross-head. The feed pumps are of the Weir automatic type, while the general service pumps are duplex pumps of the Admiralty type, made by the builders of the vessel. The circulating pumps are of the centrifugal type, there being one for each main engine and one for the auxiliary condenser, which is used while the vessel is in port, and which receives steam from the winches. These pumps are also made by the shipbuilders. A Weir feed-water heater is installed, and there is also an evaporator and distiller. The electric equipment is very complete, there being four generators of about 35 kilowatts capacity each. Electricity is used for driving the ventilating fans, of which there are a great number throughout the ship, as well as for lighting, heating and various small pieces of apparatus designed for use in the staterooms. The steering gear consists of a Brown's steam tiller and telemotor.

THE NEW ATLANTIC TRANSPORT LINER MINNEWASKA.

The passenger accommodations are all for first class passengers, of which 326 may be carried. On the boat, or upper, deck, forward, is the lounge, which is finished in white and gold, and is furnished with wicker furniture. There is a handsomely decorated skylight in the center of the room, and at the forward end a large bookcase. Square windows, arranged in pairs, extend around on three sides of the room. Amidships on this deck is the reading and writing room, which is also finished in white and gold panel work with colored windows. The furniture in this room is of mahogany. At the after end of this deck is the smoking room, which is paneled in oak and upholstered in plain crimson morocco. Between the reading room and the smoking room is the Marconi station. The shelter deck is given over entirely to staterooms, of which there is a great variety, ranging from single-berth rooms to suites de luxe, comprising sitting room, bed room and bath. All staterooms are handsomely decorated, and the inside rooms are lighted and ventilated on the Bibby system. At the forward end of the saloon deck is the dining room, which extends the entire width of the vessel, and is framed and paneled in oak.

FURNACE REPAIRS AT SEA.

The flattening or collapsing of furnaces in marine boilers is, even at the present date, a subject which is invested with a degree of uncertainty. There are several reasons advanced in order to account for the collapsing of such furnaces, but the true causes are not yet made sufficiently clear to entirely prevent the occurrence of such troubles, even with the ordinary amount of careful supervision. A rather interesting example of this class of difficulty recently occurred in the case of a furnace whose diameter was 3 feet 8 inches, and length 6 feet, the steel was ⅞ inch thick, and the boiler pressure was normally 160 pounds per square inch.

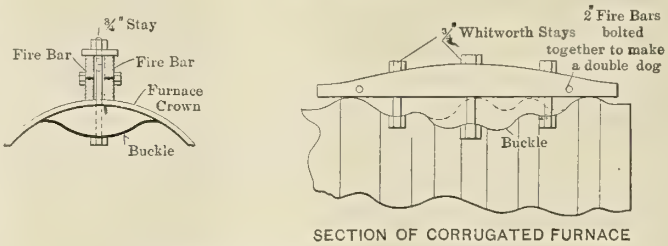
The boiler had been under steam for some time previous to the accident, and the furnace in question partially collapsed about ten days from the beginning of the voyage. Before the voyage, however, the boilers had been under steam for some ten or twelve days at the loading port. Owing to exceptional conditions, the vessel had to have steam raised and the fires banked successively several times in succession. This was because the loading of the cargo had to be carried out under difficulties; the jetty at which the vessel lay was in an open bay, and not in a sheltered harbor, and the vessel had therefore to put off to sea whenever the weather became too bad for her to remain alongside the jetty from which the cargo was being taken. It is probable that this successive raising of steam and banking, in the course of loading, had some effect in causing the furnace to show weakness and to collapse at a later date.

Among other points, it may be fairly allowed that the continued heating and partial cooling of the boilers before actually starting on the voyage caused the scale to crack away from the tubes, so that it dropped on to the furnace crown, becoming lodged in the corrugations and thus preventing free contact of water with the exterior surface of the furnace. The fact that the boilers were under banked fires so much of the time would also undoubtedly conduce to the evil, as boilers have a considerably less active circulation in such cases. This would cause steam to cling to the heating surface, in this way holding the water away from the metal and rendering the furnace liable to overheating.

Another cause which might have been conducive to, although it would not be called the prime origin of, the evil, was the fact that while the boilers were used in moving the ship during loading operations, a considerable amount of water was lost at each operation. This water had, of course, to be replaced, and the only available source from which such supplies could be taken at the time was the sea. No marine engineer cares to put salt water into his boilers, but sometimes there is no alternative. In the case mentioned, the loss was minimized as much as possible and the density did not at any time during the voyage become excessive. At the time that the furnace buckled, and for some days previously, the density had remained the same, as no salt water had entered the boiler after leaving the port. The density was from $\frac{2\frac{1}{2}}{32}$ to $\frac{2\frac{3}{4}}{32}$, or about 12 to 13 ounces to the gallon. This cannot be considered excessive, as the saturation point is reached at $\frac{7}{32}$, or 35 ounces to the gallon.

Blowing down was not resorted to, because, although the density could be lowered in that way, certain solids would be deposited on the heating surface which could not be expelled from the boiler. In this way the trouble would have been aggravated. The course actually pursued was as follows: When the furnace, which was the center and lower furnace in the starboard boiler, buckled, that boiler was shut off, fires were drawn and the water blown out. The connections were all closed and the doors knocked in. As soon as possible the boiler was emptied and examined, and it was decided to stay the furnace according to the method about to be described. The furnaces were also scaled, and a quantity was found in the corrugations although there was practically none on the ridges. This gives rise to the belief that the scale had fallen from the tubes, having been cracked off by the expansion and contraction, due to the raising and banking of fires at the beginning of the voyage.

The furnace was stayed, as shown in the illustration, by means of three ¾-inch studs passing through the middle of



TEMPORARY REPAIRS TO A COLLAPSED FURNACE.

the furnace, to which was clamped a double dog, made of two ordinary firebars bolted together and laid lengthwise on the furnace crown. During the time the boiler was laid off, the engines were kept going by the remaining boiler. Although the furnaces were scaled and a temporary dog fixed in place on the low furnace, the boiler furnace was cleaned, the doors replaced, the boiler filled up, the fire lighted and steam raised in about 36 or 38 hours. As this time includes that necessary for the boiler to cool, and also to raise steam at the end of the repair, it may be considered a fairly quick piece of work.

On arrival at the discharging port, the boilers were both laid off and the furnaces put back into circular shape again by means of a hydraulic ram. The Whitworth stays, shown in the sketch, were renewed by threaded stays 1 inch in diameter, and instead of the three shown, five were used. This port repair was therefore practically a repetition of the one made at sea, only accomplished with better materials and more facilities.

A GAS-DRIVEN LAUNCH.

The accompanying illustrations show the adaptation of a producer gas plant to a 40-foot cabin cruiser built by MacLaren Bros., of Dumbarton. The boat, which has been named the *Pioneer,* has been built and equipped throughout by the same firm, the engine alone being made outside the Sandpoint yard. The gas plant is of the suction type, employing anthracite coal as fuel. A hopper of sufficient capacity for four hours' running is situated immediately over the producer, and can be replenished through a hatch in the fore-end deck. The producer plant appears to be similar in design and construction to those already in use for land purposes. The necessary water supply for cooling and scrubbing the gases is obtained from the sea, the salt water having proved to be, we are informed, quite satisfactory for this work. A certain amount of fresh water must, however, be carried for supplying the vaporizer, and as only a comparatively small quantity is used for this purpose, a sufficient supply is provided in the bilge tanks of the vessel for thirty-six hours' continuous running. Fuel accommodation is also provided for this period.

No provision is made with regard to shaking the fire grate to prevent clinkering, for, according to the makers, the motion

of the vessel is quite sufficient. Coke is employed as a cleansing medium in both the wet and dry scrubbers. In the former the gas enters at the bottom, meeting a spray of sea water from the top. Reaching the upper portion of the wet scrubber

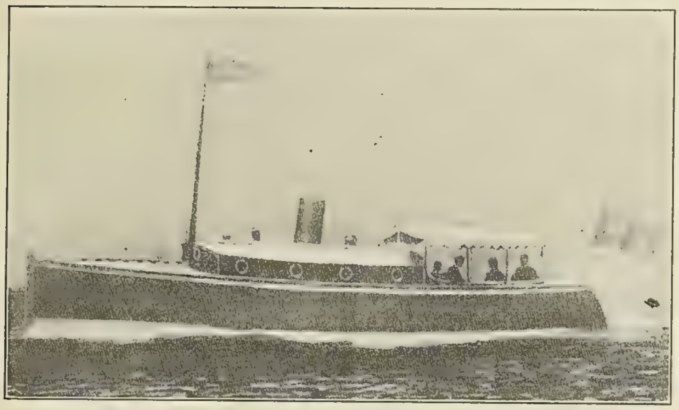


FIG. 1.—40-FOOT CABIN CRUISER PIONEER.

the gas is taken to the dry scrubber, through which it passes in a downward direction.

The water spray is found to give ample cooling of the gases, and, provided fairly clean coal is used, cleaning of the scrubbers is only necessary at very long intervals.

The engine fitted (Fig. 2) is a four-cylinder Crossley of 30 nominal horsepower, but it gives rather more than this when running on producer gas. The engine speed is low for the type of engine, the maximum being 800 revolutions per minute. The compression is very high, being approximately 120 pounds per square inch, and it is claimed that combustion is quite complete. When the engine is cold it is started up on petrol (gasoline) and runs on this fuel until the necessary quality of the gas can be obtained from the producer.

The engine is set in a true horizontal plane, and it drives

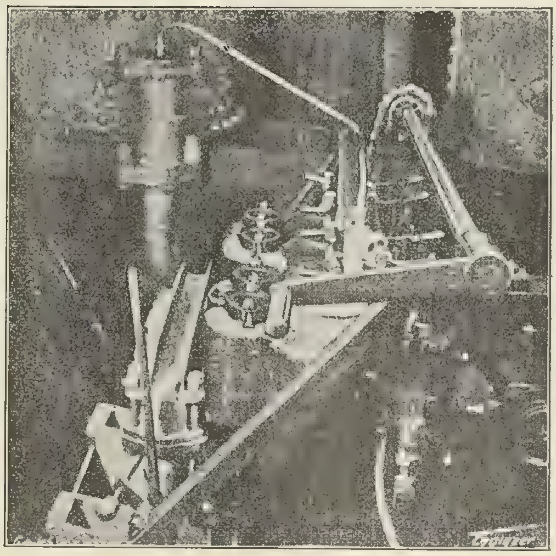


FIG. 3.—FOUR-CYLINDER, 30 HORSEPOWER CROSSLEY ENGINE.

through a universal joint an inclined propeller shaft, which carries a two-bladed reversible propeller.

A trial run was made recently at which a number of Clyde yachtsmen and gas engineers were present. Although the weather conditions were most unfavorable, satisfactory runs with and against the wind were made, a mean speed of 9 knots being attained. The cost of running was calculated at 2½d. per hour. We are informed that the engine showed a remarkable flexibility on suction gas, and a total absence of smoke or smell either in the engine room or at the funnel was another feature of the plant. We understand that MacLaren Bros. are at present negotiating for some large ships which are to be fitted with a suction gas producer plant.—*The Engineer*.

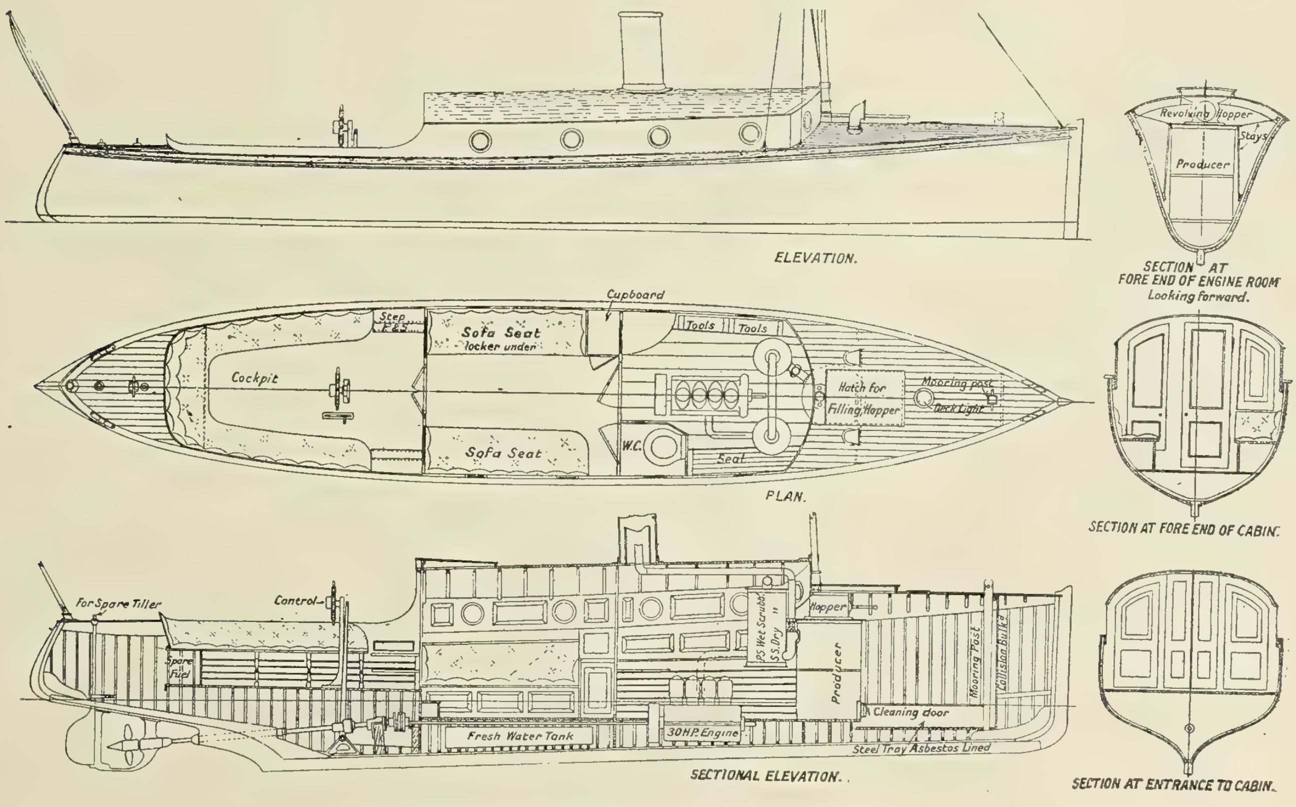


FIG. 2.—GENERAL ARRANGEMENT OF THE CABIN CRUISER PIONEER.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

A Towing Tank for Research Work.

Somewhat over a year ago Mr. A. F. Yarrow, vice-president of the Institution of Naval Architects, offered to build an experimental model towing tank, provided one of the most modern character could be established for a sum not exceeding £20,000 ($97,330), and that it be established at the National Physical Laboratory, at Bushy. It was also stipulated in Mr. Yarrow's offer that suitable provision should be made both as regards staff and means for conducting research work, as well as for experimental investigations of a confidential character which private firms might desire; and, finally, that a sufficient sum be provided to insure the tank being efficiently carried on for a period of not less than ten years. This proposal was submitted to the council of the Institution of Naval Architects and gratefully accepted, a committee being appointed to take the necessary steps to carry out the provisions of Mr. Yarrow's proposal.

The first thing done was to make provision for the proper maintenance of the tank for ten years. It was considered necessary to provide at least £2,000 ($9,733) a year for this purpose, and an appeal was made to the leading shipbuilding and ship-owning firms for yearly contributions to this fund. As a result, at the time of the 1909 meeting of the Institution the sum of £1,240 ($6,035) per year had been subscribed, and this was considered a sufficient guarantee to proceed with the establishment of the tank.

While it is to be regretted that the entire sum necessary to insure the maintenance of the tank for ten years was not forthcoming at the outset, there is little doubt but that before the tank is completed the entire amount will have been subscribed. The past year has been one of extreme hardship in the shipbuilding industry, and funds for any purpose whatever, no matter how worthy, have not been easy to secure. Shipbuilders are by no means blind to the advantages which would accrue not only to themselves individually, but to the engineering profession as a whole, by the establishment of this tank, and we are confident that the project will receive the hearty support it deserves.

Standardizing Shipbuilding Materials.

During the past eight years a great undertaking has been in progress, the size and scope of which has not been generally recognized except by those who were immediately engaged in the work. This work has included the standardization of the size and shape of structural materials and the standardization of tests for such material. It was first proposed by the British Iron Trade Association in 1900, and in 1901 a committee was appointed, consisting of representatives of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Iron and Steel Institute and the Institution of Naval Architects, to carry out this work. Out of this small representative committee, which ultimately became known as the Main Committee on Engineering Standards, has grown an organization embracing thirty-nine various sectional committees and sub-committees, with a total membership of approximately three hundred. Before arriving at any standard, it was first necessary to obtain from the steel makers, merchants, shipbuilders and engineers, and from representatives of various classification societies, evidence regarding the necessity and desirability of retaining various structural shapes then in use; and it was found that radically different sections would be necessary for shipbuilding work, for bridge and building construction, and for railway rolling stock. Committees were, therefore, appointed to deal with each of these classes of material and to so relate the three classes that a joint list could be obtained if possible. The committee which had in charge the standardizing of sectional material for shipbuilding work included representatives of the British Admiralty, the Board of Trade, Lloyds, the Bureau Veritas and the Steel Makers' Association, together with representatives of steel merchants, shipbuilders, etc. It would be impossible to give all the details of the vast amount of work involved in arriving at a standard; but obviously the need for it was very great, as not only was there a wide

variation in the profiles of similar sections made by the same concerns, but also between professedly similar sections made by different firms. The sections varied both as regards the radii at the roots and corners and also in the proportions of thickness to dimensions.

Some of the more important decisions made by the committee are as follows: it was decided to depart from the practice of tapering the flanges of angle bars and adopt parallel flanges. The thicknesses at which practically correct profiles could be obtained and the range of thickness for each size were specified, and the radii at root and toe were also standardized. Lloyd's sketches for bulb tees, plates and angles were practically adopted, except that it was decided that the standard web should be of the least thickness in proportion to its depth which was consistent with ease in rolling. It was found that the development of channel sections had proceeded entirely in the wrong direction, as it had been customary to keep the flanges at a constant thickness and vary the weight and strength of the bar by adding thickness to the back of the web. In the new standard section the webs are all 2-20 inch less in thickness than the flanges. Zee bars were dealt with in much the same way; but the standardizing of tee sections was left to the bridge committee, as this is a shape seldom used in shipbuilding.

All this work was simply preliminary, leading up to the important point of deciding how many sections should be standardized, a result which could only be obtained by compromise. It was natural that the steel makers should desire to work with the fewest number of sections possible, while, on the other hand, shipbuilders and classification societies wished to have the very fullest range which could be obtained. The final decision arrived at by the committees for shipbuilding, bridge sections and railway rolling stock material resulted in the following number of standard sizes: Equal angles, 16; unequal angles, 30; bulb angles, 20; bulb tees, 6; bulb plates, 7; zee bars, 8; channels, 27; beams, 30; tee bars, 22. The profiles are stated in inches and fractions of inches for the flanges and webs, and in decimals for the thickness.

The standardizing of tests and test pieces was the second important work undertaken, and having accomplished this the committee then took up the question of breaking stresses and elongations, and these figures, while essentially compromises, were made as fairly as possible, taking account of various interests affected. On the whole, this has been a stupendous piece of work, and one which reflects great credit on those who have had it in charge, and who, for the most part, have done their work faithfully and well without any remuneration whatever.

Scout Cruiser Trials.

As yet, very little information has been made public regarding the results of the recent competitive trials of the United States scout cruisers *Salem*, *Birmingham* and *Chester*. The trials were disappointing, in that accidents to both the *Birmingham* and *Salem* marred their performance. The injury to the *Salem* was caused by some foreign substance becoming lodged in the starboard turbine and damaging the blading of the fifth stage. As this, of course, had a decided effect upon the speed and power of the ship, it has been decided to give the *Salem* another set of trials as soon as the damaged turbine has been repaired. Details of the accident to the *Birmingham* have not been made public, but it is reported to have been due to a rupture in the main steam line. This accident occurred on the full-speed trial, which the vessel was forced to discontinue after twelve hours.

The preliminary report just given out by the Navy Department covering the steam and coal consumption of the three vessels during the four series of tests is as follows: For the first test, which was at 10 knots speed for ninety-six hours, the feed-water consumption in tons per day was as follows: *Birmingham*, 10.55; *Chester*, 10.97; *Salem*, 11.66. The coal consumption for this test in tons per day was: *Birmingham*, 31.74; *Chester*, 40.44; *Salem*, 53.85. The second test was at 15 knots speed for fifty hours, with the following results: Feed-water, tons per day, *Birmingham*, 13.9; *Chester*, 13.2; *Salem*, 12.12; coal consumption, tons per day, *Birmingham*, 71.23; *Chester*, 85.62; *Salem*, 107.23. The third test was at 20 knots speed for ninety-eight hours, with the following results: Feed-water, tons per day, *Birmingham*, 26.1; *Chester*, 16.8; *Salem*, 17.51; coal consumption, tons per day, *Birmingham*, 153.47; *Chester*, 157.15; *Salem*, 202.03. The fourth test was at maximum speed for twenty-four hours. The consumption of feed-water in tons per day was for the *Birmingham*, 120.4; the *Chester*, 27; the *Salem*, 45.625. The coal consumption for this latter test was not given, but unofficial reports credit the *Chester* with 417 and the *Salem* with 415 tons per day. The speed of the *Chester* on this test was 25.08 knots, and that of the *Salem*, 24.54. The *Birmingham* discontinued the test after twelve hours, and her speed and coal consumption are not given.

Comparing these figures with those obtained on the preliminary acceptance trials, we find that in the case of the two turbine-driven ships the coal consumption was noticeably higher in the competitive tests than in the acceptance trials, while in the case of the *Birmingham* it was about the same; and whereas both turbine ships showed greater economy in coal consumption than the *Birmingham* on the acceptance trials, the *Birmingham* proved most economical on the competitive trials. Also, on the acceptance trials the steam and coal consumption of both the turbine-driven ships were practically the same, whereas on the competitive trials the *Chester* (Parsons turbines) showed greater economy in both respects than the *Salem* (Curtis turbines). A fair comparison cannot be made, however, until the *Salem* has repeated her trials. This ship is undoubtedly capable of a better performance.

GEORGE WALLACE MELVILLE.*

Too often the pathway to greatness and fame is marked by the wreckage of competitors, and, even, friends, who have been ruthlessly thrust aside in the egoism of selfish ambition. Thus there may be a grudging admission of ability, but there is no love, no true admiration. When, on the other hand, the hero has always been the helper and friend of his companions, when he has cheerfully acknowledged their aid to his success, then every member of the profession feels that the talent of the helper is reflected on the whole body, and they love the man while they rejoice in his reputation.

George Wallace Melville is such a man. He has been one of the famous men of engineering so long that we find it hard to remember a time when his name was not synonymous, as it is now, with all that represents progress and achievement in our profession. Yet this reputation, as we can now see it, on looking back over his life, seems to have been inevitable from the beginning.

The chief characteristics which have made him great are, in my judgment, indomitable courage and unbounding honesty. It is possible for a man to have great mental ability and yet fail of true greatness if he lack these essentials.

Admiral Melville's Arctic record, which first brought him an honest reputation, where he displayed a heroic courage which has never been surpassed, and for which Congress advanced him a grade in the navy, is well known. This, however, was only a repetition of other instances of absolute fearlessness, beginning with his earliest days in the service. When he became engineer-in-chief, the same courage, but rather on the moral than the physical side, was shown. Beginning with his first annual report, he spoke out fearlessly, setting forth the truth as he saw it, and striving always for advancement and efficiency. Complaint was made to President Cleveland of the plain speech in this first report, but that strong man read it himself and said, "We want more such men."

His courage professionally is also remarkable, and it is not the recklessness of the gambler who will take great risks for a big stake, but the cool, matured determination of the thinker, who has weighed all the chances and believes he is right. Along with this is a faculty which, I believe, is a characteristic of all great men, that, having made his decision, de does not worry about the result. Able men of minor rank are always fearful that something may go wrong and their reputation be injured. The really big man who does things will make some mistakes, but he is strong enough not to dread them. A notable instance of this kind in Melville's career was his use of triple screws for the *Columbia* and *Minneapolis*. Some of his friends, for whose professional opinion he had the highest regard, urged him not to make the experiments, but he had studied the problem carefully, was satisfied of the correctness of the solution, and persevered. The result was, perhaps, the greatest triumph of his professional career.

His ability as an executive was of a very high order. The features of deciding a case and then refraining from worry are evidence of this. He had a rare talent for choosing able assistants, and, having proved them, he left in their hands all of the detail work, thereby giving himself time for the careful study of the larger problems. The effect of this was very marked in stimulating the entire staff to highest efficiency and zeal, and every man counted it a pleasure to work, without regard to hours, for the credit of the "Chief" and the glory of the service.

With respect to his professional work, it is notable that his career as engineer-in-chief is the longest on record—sixteen years. I think this is perhaps the longest service of any bureau chief in the history of the Navy Department. During this time he was responsible for new designs of machinery for about 120 vessels of all classes, twenty-four being battleships and forty-one armored vessels of all kinds. The aggregate horsepower was close to a million and a quarter. Best of all, there were no "lame-ducks" and no failures.

He was the first to use watertube boilers in large war vessels, and when he made one installation he had the courage to resist the temptation for notoriety which would have come from using them generally. He preferred to wait for experience. A famous engineer abroad started later, but went in on a large scale, with much subsequent regret. When the trial period was over, Melville adopted them generally. There was a great temptation when forced draft was adopted to cut boiler weights too low. This was done in one foreign navy with disastrous results. Melville was progressive but conservative, and had no boiler troubles. He was the first to determine the actual coal consumption on trials, with results that were startling to those who had been guessing and projecting the steaming endurance on the guesses. He was also the first to use the method of determining trial speeds, known as "standardizing the screws," which is the simplest, most accurate, fairest to contractor as well as government, and the least expensive.

It is to him also that we owe our first high-speed battleship. When in 1898 the proposals for the *Maine, Missouri* and *Ohio* were being prepared, he stood alone in his demand for 18-knot ships. There was some casual opposition and much indifference. If he had not persisted these three ships would have been copies of those designed two years before, and we should have been, for three years longer, behind the other navies of the world in battleship speeds.

During the war with Spain he brought out the repair ship and the distilling ship. The idea of the former was not new, but the *Vulcan* was far the most complete vessel of the kind equipped up to that time. The latter was to furnish fresh-feed water for the boilers, and enable a vessel with a storage bunker capacity of 3,000 tons to supply 60,000 tons of water, the equivalent of about ten ordinary tank ships.

The experimental work carried out under his direction would require a book to give any detailed idea of its magnitude and results, but it must be mentioned that it was all published in his annual reports, so that the profession could have the benefit of it. Almost the last interesting experiments during his administration were an elaborate series of tests of oil fuel, probably the most comprehensive ever made.

My brief sketch of this famous man would be incomplete if I failed to speak of his personality. The lion-like head and the frank speech have led some to say that he is one of the old Vikings spared to us a thousand years after the others have gone. But if this leads any to think that he is harsh and cold there could be no greater mistake. Like all strong natures, he is pronounced in his feelings, but he is a man of warm affection, and when he has once taken you into his heart you are sure of an abiding place there as long as you are worthy. It is often said that no man is great to his intimates, but I have been with him, day by day, for years; have seen him under all conditions, and my admiration and love for him have steadily increased as the years go by. I have no ambition to be a Boswell, and I have not kept notes of his doings; but I have seen the daily workings of a great, kind heart, tender for the humble yet fearless toward the great; and I can truly say that I count it a privilege and an inspiration to have been a trusted friend and helper of this noble man, who has exemplified the highest type of manhood and added new lustre to the profession of engineering.

* Abstract of an address by Walter M. McFarland at the presentation of a portrait of Admiral Melville to the National Gallery, Washington, May, 1909.

REAR ADMIRAL GEORGE WALLACE MELVILLE.

(From a painting by Sigismond de Ivanowski, presented to the National Gallery, Washington, D. C.)

Progress of Naval Vessels.

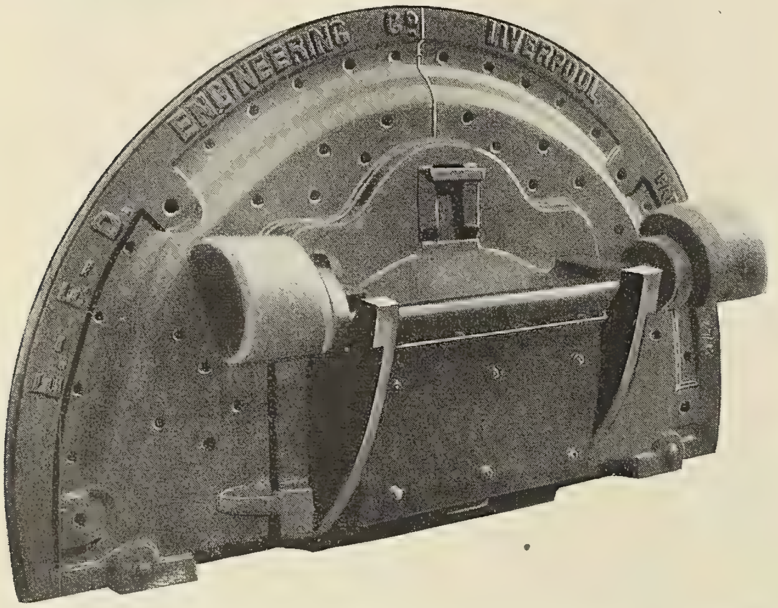
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Apr. 1,	May 1.
			BATTLESHIPS.		
S. Carolina..	16,000	18½	Wm. Cramp & Sons..........	86.9	90.0
Michigan ...	16,000	18½	New York Shipbuilding Co...	95.2	97.4
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	73.0	77.9
North Dakota	20,000	21	Fore River Shipbuilding Co...	77.9	81.5
Florida	20,000	20¾	Navy Yard, New York.......	8.4	11.9
Utah	20,000	20¾	New York Shipbuilding Co...	10.8	14.9
			TORPEDO-BOAT DESTROYERS.		
Smith	700	28	Wm. Cramp & Sons..........	71.4	81.6
Lamson	700	28	Wm. Cramp & Sons..........	69.4	75.7
Preston	700	28	New York Shipbuilding Co...	64.1	70.7
Flusser	700	28	Bath Iron Works............	63.2	68.7
Reid	700	28	Bath Iron Works............	63.0	67.8
Paulding ...	742	29½	Bath Iron Works............	7.0	9.8
Drayton	742	29½	Bath Iron Works............	7.0	9.7
Roe	742	29½	Newp't News Shipbuilding Co.	29.5	38.6
Terry	742	29½	Newp't News Shipbuilding Co.	27.4	33.7
Perkins	742	29½	Fore River Shipbuilding Co...	15.7	22.0
Sterrett	742	29½	Fore River Shipbuilding Co...	15.7	22.0
McCall	742	29½	New York Shipbuilding Co...	10.5	11.7
Burrows	742	29½	New York Shipbuilding Co...	10.0	11.3
Warrington..	742	29½	Wm. Cramp & Sons..........	12.4	16.0
Mayrant	742	29½	Wm. Cramp & Sons..........	12.2	16.1
			SUBMARINE TORPEDO BOATS.		
Stingray	...	..	Fore River Shipbuilding Co..	82.0	89.8
Tarpon	...	..	Fore River Shipbuilding Co..	81.7	89.7
Bonita	...	..	Fore River Shipbuilding Co..	76.7	81.4
Snapper	...	..	Fore River Shipbuilding Co..	76.3	80.4
Narwhal ...	...	..	Fore River Shipbuilding Co..	84.2	89.7
Grayling ...	...	..	Fore River Shipbuilding Co..	77.8	84.6
Salmon	...	..	Fore River Shipbuilding Co..	66.6	75.3
Seal	...	..	Newp't News Shipbuilding Co.	8.8	12.7

ENGINEERING SPECIALTIES.

The Boltless Improved Boiler Furnace Front.

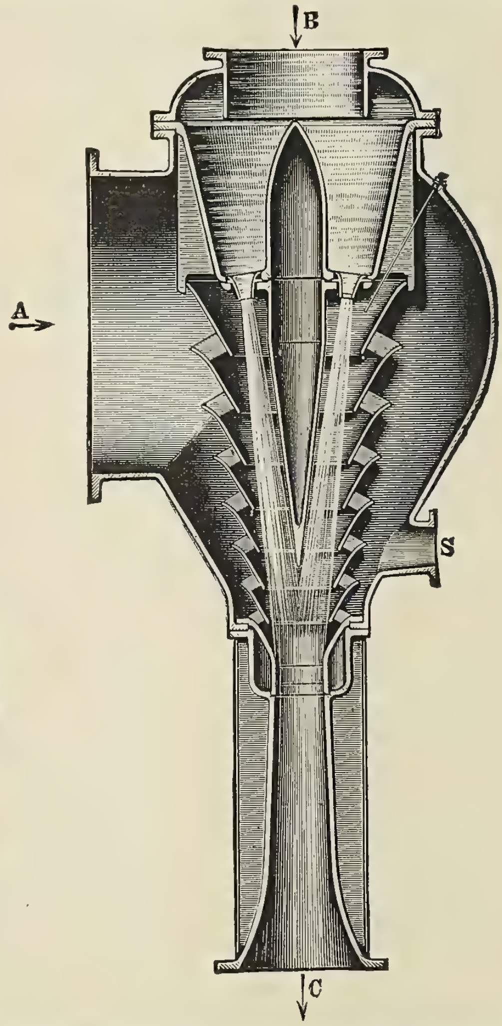
A new patent boltless furnace front has recently been fitted to the boilers of some of the largest steamships in the North Atlantic service, notably the *Adriatic, Baltic, Oceanic* and *Laurentic*. In these furnace fronts the front plate, door frame and flame plates can be assembled in place without tools of any kind. This simplicity of arrangement makes it possible for a laborer or fireman to take down or erect any of



the parts in a few minutes. The front plate is divided vertically, and avoids the use of bolts. This construction removes the liability to failure due to unequal expansion and contraction, as it leaves the front free to expand or contract as the temperature changes. No alteration of the existing arrangements is necessary to apply these frames and doors, as they can be fitted to the ordinary boiler fronts. These furnace fronts, which are suitable for both natural draft and forced draft in closed stokeholds, are manufactured by the "Economical" Forced Draught & Engineering Company, Ltd., 5 Castle street, Liverpool.

The Koerting Multi-Jet Eductor Condenser.

Due to the fact that steam turbines operate more economically when running with high vacua, and also to the fact that the sizes and, consequently, the load factors, of power plants have increased to such an extent that a much larger proportional capital outlay is justified for the auxiliary machinery, more efficient condensing apparatus is necessary than was formerly the case with reciprocating engines, small power plants and small load factors. To meet this demand the Schutte & Koerting Company, Philadelphia, Pa., have placed on the market a multi-jet eductor condenser for installations of 500 horsepower and upwards. This condenser embodies the essential features of the Koerting single-jet eductor condenser, which has been largely used for many years in plants ranging in size up to 500 horsepower. The multi-jet condenser consists, as shown in the illustration, of a number of converging condensing jets, meeting and forming a single jet in the lower part of the condensing tube. The tube is cast in one piece, and consists of a series of concentric nozzles of



gradually diminishing power. The steam flows through the annular passages between the nozzles which guide it, so that it impinges at suitable angles on the condensing jet. The steam, which strikes the condensing jet at high velocity, is condensed, and the particles of water into which it is converted, having the kinetic energy due to the steam velocity, go into the jet and contribute to the momentum needed to discharge this, together with the entrained air and non-condensible gases,

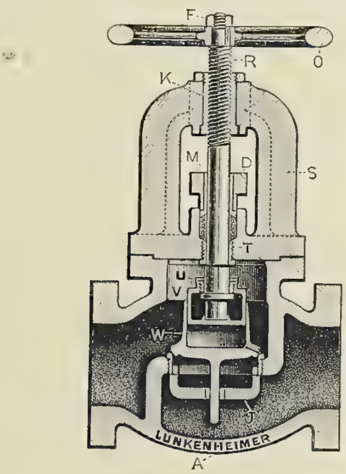
against the resistance of the atmosphere. The condensing tube in vertical section is an inverted cone. In the upper part of the tube the steam is in contact with the coldest water, and condensation is keenest, so that a greater weight of steam is condensed per unit of area of contact than is the case in the lower part of the tube, where the water is hotter. Due to the conical shape of the tube, the sectional area of the steam passages increases from the bottom upwards, thus securing that the sectional area of the ports is proportional to the volume of steam they have to pass. Owing to this the steam velocity is nearly constant from the top to the bottom of the tube, and the drop of vacuum between the interior of the tube and the exhaust chamber can be reduced to a minimum. There must, necessarily, be a higher absolute pressure, or, in other words, lower vacua in the exhaust chamber than in the interior of the tube, as, otherwise, there would be no flow of steam through the ports to the condensing watertubes.

A drop of vacuum equal to ½ inch mercury column, it is claimed, suffices, maintaining 28 inches mercury vacuum, and the actual working vacuum obtained is, therefore, only ½ inch lower than the highest theoretical vacuum, as determined by the discharge temperature and corresponding vaporizing point of the condensing water. It is claimed that with this condenser the ratios of water to weight of steam condensed are, for equal vacua, practically the same as are required for surface condensers. To secure satisfactory working under all conditions of load variation on turbines or engines to which they are attached, it is only necessary to supply the water to the condensers at a pressure at the level of the water inlet flanges equal to 21 feet water column, or, say, 9 pounds per square inch. When, as is usually the case, there is no gravitation supply of water available, it is necessary to use a circulating pump, and, if a motor or belt-driven centrifugal pump be used, the water may be delivered direct into the condensers, or, what is preferable, it may be pumped up into a standpipe to get rid of the air, more or less of which is always contained in the water, and which would naturally influence the vacuum considerably.

From this description it is obvious that the condenser requires no air pumps, has no moving parts, and, consequently, no wear and tear. It is also claimed that it is very simple to operate and requires little space.

The Lunkenheimer Non-Return Boiler Stop Valve.

When several boilers are connected to a common header, it is evident that if a tube is blown out or a fitting ruptured, the steam from the battery of boilers will rush into the header

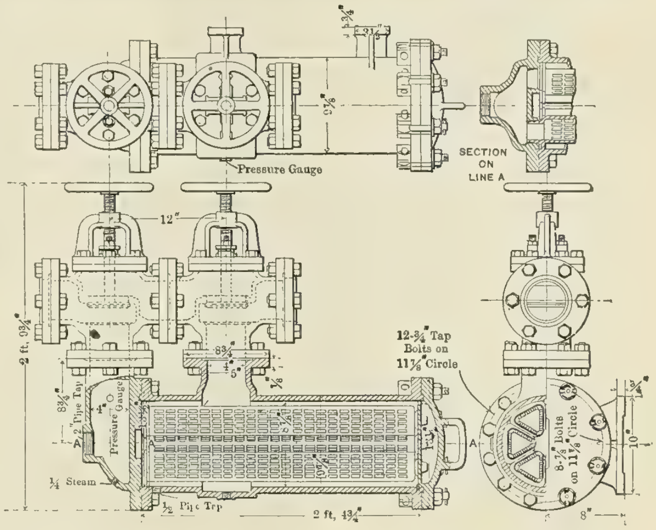


and discharge through the boiler which is disabled. The difficulty of closing a stop valve in the event of such an accident is apparent. The Lunkenheimer Company, Cincinnati, Ohio, has designed a non-return boiler stop valve which is claimed to entirely overcome this danger. This valve is intended to be placed between the boiler and header. It prevents steam being turned into it when it has been cut out for cleaning or repairs, for the reason that the valve cannot be opened by hand. It can, however, be closed by hand the same as any other stop valve.

The company states that these non-return valves are made only of the best materials, and that the areas are unusually large and free. The internal dashpot and piston prevent chattering of the disc. All wearing parts are made of bronze, and the gland and stuffing box are bronze bushed. For use with superheated steam these valves are made of puddled semi-steel, with nickel trimmings and nickel-steel stems. The valves are made in sizes from 4 to 10 inches, inclusive, and can be furnished with screw or flange ends.

A Feed-Water Grease Extractor.

The illustration shows a new feed-water grease extractor, manufactured by the American Steam Gauge & Valve Manufacturing Company, Boston, Mass. Two valves forming the inlet and discharge from the extractor, when seated as shown in the drawing, force the water into the shell of the extractor through the cartridges, and, in this manner, the grease is extracted. When the valves are seated on the lower seat, they form a by-pass, so that the shell of the extractor can be opened, the cartridges taken out, and either replaced with an extra set



or cleaned and put back. The ratio of the openings in the cartridges to the inlet of the extractor is 48 to 1. The cartridges are held firmly in place by seating in the base, and by plate and spring washers at the top. The pressure gages are applied to both the main chamber and base, so as to note the difference in pressure and tell when the pressure in the main casing is increased, due to the restricted flow of the water by the covering of the cartridges becoming filled with grease. Provision is also made in the base to connect a ¼-inch steam pipe, driving steam into the inside of the cartridges, and in this manner cleaning them, so as not to necessitate taking the cartridges out as often as would otherwise be necessary. The shell of the extractor is small and the cartridges are triangular.

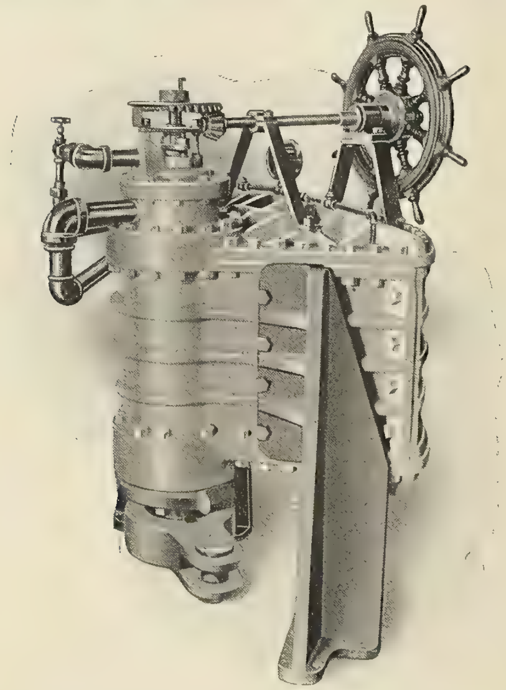
The Bergesen Automatic Steering Engine.

Most steering engines are so constructed that when the rudder is moved only 2 or 3 inches the steering engine makes from ten to fifteen revolutions, and each of the cylinders is filled with high-pressure steam from ten to twenty times. This involves, of course, a great number of rapidly-moving parts, requiring constant readjustment, careful oiling and skilled attention.

A new steering engine has recently been placed on the

market, known as the Bergesen direct automatic steering engine, manufactured by the Bergesen Manufacturing Company, 74 Broadway, New York, in which for a corresponding movement of the rudder the piston moves only from ½ to 1 inch from its middle position, and only sufficient steam at low pressure is admitted on one side of the piston to secure the small amount of movement in the piston and rudder, consequently the engine performs its work noiselessly. It is also claimed that putting the rudder hard over to either side while the ship is under full headway is performed noiselessly.

The piston and piston rod of the engine are of one piece of steel, being about eight times the strength of the old construction of securing pistons to piston rods. There are no eccentric rods, eccentrics or sliding valve stems. One oscillating valve stem and valve controls all the movements of the engine. A special style of piston packing is used, which, it is claimed, takes up its own wear and lasts for a very long time. It is also claimed that the valve in the Bergesen engine takes

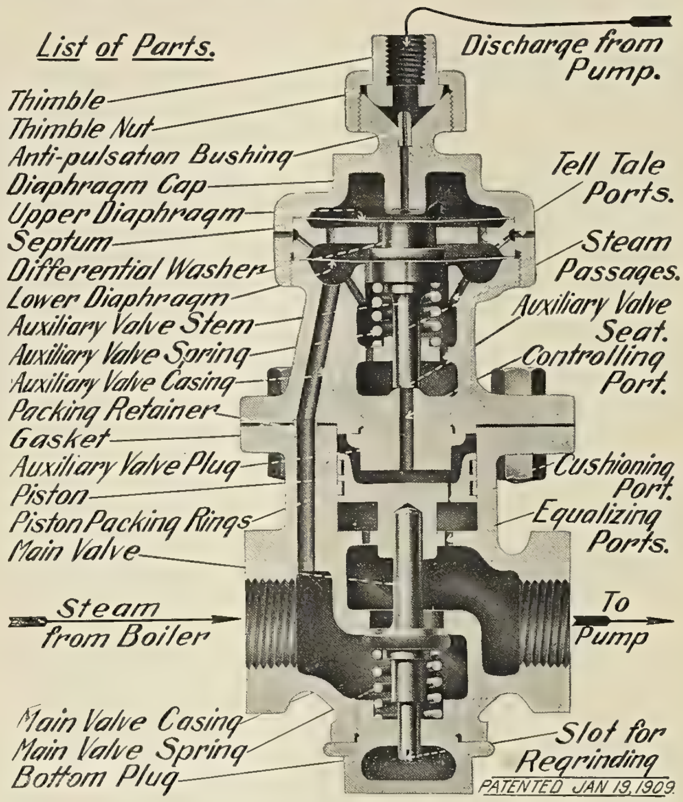


up its own wear, as the pressure on the valve holds it on its two seats, so that it remains steam-tight. No gaskets or joint material are used in assembling the engine, consequently there are no joints to blow out or renew. There is not a single bolt, nut or washer of any sort in the cylinder, piston or steam chest. The joints are all carefully made by scraping and grinding to a steam-tight fit, metallic packing being used on the piston and valve-stem rods. The limits of oscillation of the valve-stem lever are adjustable, so as to control the movement of the rudder and stop it just before it arrives at the hard-over point on either side. The movement of the rudder is the same as that of the lever on the valve stem or from zero to 45 degrees on either side, so that if a lever is used in the pilot house, or on the bridge in place of a wheel, the position of the lever indicates the position of the rudder. Transmission from the bridge or pilot-house to the valve and engine can be made through shafts and gears, ropes, chains or rods and bell cranks.

This steering engine is suitable for use on all types of vessels, from the largest ocean liners and warships down to the smallest river steamers, yachts, tugs, motor boats and launches.

The Foster Excess Pump Governor.

This pump governor was fully described on page 199 of our May issue, but, due to a mistake, for which we were in no



way responsible, the manufacturers, the Foster Engineering Company, of Newark, N. J., sent us an engraving showing a sectional view of their class U pressure regulator, which was used as an illustration of the pump governor. We publish herewith a sectional view of the excess pump governor; for details of which see page 199 of our May issue.

TECHNICAL PUBLICATIONS.

The Engineering Index Annual for 1908. Size, 6½ by 9 inches. Pages, 437. New York and London, 1909: *The Engineering Magazine.* Price, $2.

From the years 1884 to 1891, *The Engineering Index* was published by the Association of Engineering Societies, under the direction of Professor J. B. Johnson. From 1892 to 1895, the *Index* was edited by the Association of Engineering Societies, under the direction of Professor Johnson and published by *The Engineering Magazine.* Since 1896 the book has been both edited and published by *The Engineering Magazine.* The present work comprises the seventh volume, and includes classified lists of the most important articles published in the technical press during the year. Each article is briefly described, and information is given regarding the issue of the publication in which it appeared. In the 1908 volume, 8,248 articles are indexed, exclusive of cross-references, as compared with 7,848 in the 1907 volume. This gain in range has been obtained without material increase in the size of the book, as more careful attention has been given to conciseness in writing the descriptive legends.

Resistance and Propulsion of Ships. By Prof. William F. Durand. Size, 6 by 9 inches. Pages, 427. Figures, 109. New York, 1909: John Wiley & Sons. Price, $5.

This is the second edition of a book which, for the past ten years, has been one of the standard treatises on the subject of resistance and propulsion of ships. The scope and contents of this book are so well known by marine engineers and naval architects that little need be said regarding the general treatment of the subject. It is inevitable that progress should be made during the course of time on any subject in which there is opportunity for such extended research, as is the case

with the resistance and propulsion of ships. Development is bound to come also, from the further fact that the increased number of ships built furnishes additional data to the designer and engineer. Since the first edition was published, the chief contributions to the material available for the discussion of this subject have consisted chiefly of results of various experimental researches, the most important of these relating to the screw propeller. In the present volume, reference has been made to some of the more important recent contributions to general theory, although no attempt has been made to change the general character of the theoretical and descriptive treatment of the subject. An effort has also been made to summarize some of the more important researches which have been the results of experience, and this has been included. The book has not been increased in size, since the additional matter has simply taken the place of other matter of relatively minor importance which has been omitted.

Flag Sheet. Size, 35 by 32½ inches. Illustrations, over 400. *Liverpool Journal of Commerce.* Liverpool, 1909. Price, paper, 1s; framed and varnished, 2/6; framed and glazed, 3/6.

The "Flag Sheet" comprises over 400 illustrations of the various types of flags at present in use, and includes excellent pictures of the various ship companies' flags, international code flags, and the flags of sailing vessels, government boats and those in the international mercantile service. The chart constitutes a very fine permanent reference to all the insignia which are met on the high seas.

Tables of Properties of Steam and Other Vapors and Temperature Entropy Table. By Prof. Cecil H. Peabody. Size, 5¾ by 9 inches. Pages, 133. New York, 1909: John Wiley & Sons. Price, $1 (4/6).

The properties of steam have recently been redetermined by new and refined methods that are capable of great certainty and precision, so that computations based upon them show a satisfactory concordance. These tables, which were first published twenty years ago, and revised in 1907, have, therefore, been recomputed, basing the computations upon this information. The book includes tables of the properties of steam, and a temperature entropy table, giving solutions of all the adiabatic problems, both for saturated and for superheated steam. The methods of computation are explained in the introduction, and the steam tables are followed by tables of Naperian and common logarithms.

Internal Combustion Engines. By H. E. Wimperis. Size, 5½ by 8½ inches. Pages, 326. Figures, 114. New York, 1909: D. Van Nostrand Company. Price, $3 net.

Text-books dealing exclusively with the subject of the internal combustion engine are, by no means, as plentiful as those dealing with the steam engine, yet the growing importance of the internal combustion engine obviously creates a need for such books. The development of the internal combustion engine has been so rapid that the subject now demands individual and exclusive attention. This book is divided into three sections, the first dealing with the theory, and including chapters on the thermodynamic cycles, combustion and expansion and thermodynamics. The second section takes up gas engines and gas producers, the first chapter treating of the engine, the second of the producer, and the third of blast furnace and coke-oven gases. Section three is devoted to the oil and petrol (gasoline) engines, and includes two chapters, the first describing various types of engines and their method of working, and the second petrol (gasoline) engine efficiency and rating. To the marine engineer the portion of the book dealing with gas engines and gas producers will undoubtedly be of most interest; for it is only by the use of producer gas that large installations of gas engines can be made on board ship, the cost of fuel with oil and petrol (gasoline) engines being prohibitive, except for small installations, such as are used in motor boats.

COMMUNICATIONS.

Regarding the Indomitable.

Editor INTERNATIONAL MARINE ENGINEERING:

With reference to some statements made in regard to the *Indomitable* on page 6 in your January issue, permit me to state that:

1. The speed of this ship is as great as it has ever been.
2. The turbines are in perfect order and have not been touched by any dockyard since acceptance.

CHATHAM, April, 1909. H. KING HALL,
Captain, H. M. S. *Indomitable.*

Explosion on Board the Foca.

Editor INTERNATIONAL MARINE ENGINEERING:

Following is a brief account of the sad accident which occurred on board the Italian submarine torpedo boat *Foca,* described on page 109 of your March, 1909, issue.

The *Foca* was taking on a supply of petrol (gasoline) in the inner side of the military harbor of Naples on a very hot day, when there was no breeze, and, consequently, the atmosphere was absolutely still. Under these circumstances a certain quantity of the gases from the petrol (gasoline), which are heavier than the air, entered the light superstructure, which is set above the resistant hull of the boat, and which forms the deck. Unfortunately this danger had not been foreseen, and no means had been provided to secure the proper ventilation of the superstructure. A spark or some other form of ignition caused the explosion which destroyed the light superstructure, where all hands were collected, but the resistant hull and the inside of the boat were left absolutely unharmed. The tanks of benzine were found to be completely filled after the explosion, and the machinery, etc., was in complete order.

"B."

PERSONAL.

LIEUTENANT COMMANDER HUTCH I. CONE has recently been appointed Chief of the Bureau of Steam Engineering of the United States Navy, with the rank of Rear Admiral. Lieutenant Commander Cone was chief engineer of the battleship fleet during its cruise around the world.

NATHAN PRATT TOWNE, chief engineer of the William Cramp Ship & Engine Building Company, Philadelphia, Pa., and formerly an engineer in the United States Navy, died April 23, aged 65 years. Since 1893 he designed and superintended the construction of the engines of nearly all the battleships, cruisers and large vessels built at the Cramp shipyard.

ALEXANDER MILLER, head of the firm of Alexander Miller & Brothers, of Jersey City, N. J., died at his home in that city May 6. Mr. Miller was born in Aberdeen 65 years ago, and came to America at an early age. His first engineering experience was with the old Delamater Iron Works of Jersey City. Later he was connected with the Deeley Iron Works.

SIR DONALD CURRIE, head of the shipowning firm of Donald Currie & Company, died April 13. When a young man he was connected with the Cunard Line, working in Havre and Liverpool. He founded the original Castle Line, running between Great Britain and India, and later he established the Castle Line to South Africa, which, since merging with the Union Line, now has a fleet of more than fifty vessels, aggregating about 325,000 tons. Sir Donald was knighted in 1881, and was a member of Parliament from 1880 to 1890.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

912,291. ELECTRIC LOG. JOHN H. CUNTZ, OF HOBOKEN, N. J.

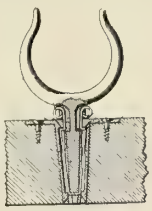
Claim 2.—The combination with a propelling member of a log, of a flexible shaft, an electric generator, means for steadying the speed of the rotating generator including a torsional shaft, a plurality of indicators and conductors from the generator to said plurality of indicators. Four claims.

913,372. MEANS FOR SIGNALING OR EFFECTING OPERATIONS BY MEANS OF SOUND VIBRATIONS. JOHN GARDNER, OF KNOTT END, NEAR FLEETWOOD.

Claim 2.—Sound signaling apparatus comprising in combination a sound-receiving transmitter, a telephonic receiver in circuit therewith, a tunable diaphragm therefor, microphonic contacts upon and operable by said diaphragm and in a normally closed electric circuit, a device included in said circuit and having a movable part which moves when the contacts are vibrated and the current is consequently reduced, a local electric circuit, and a signaling instrument contained in said local circuit, such local circuit being controlled by the said movable part to affect the signaling instrument upon and during the persistence of the microphonic vibrations. Five claims.

913,457. OAR-LOCK. CHARLES BESTMAN, OF FRIDAY HARBOR, WASH.

Claim 1.—In a device, a keeper having a constricted opening, an oar lock consisting of a yoke and a tapered stem for engaging the keeper



having oppositely arranged longitudinal grooves, and spring members in the grooves provided with off-set portions for engaging the constricted opening. Two claims.

913,617. RING BUOY. HERMAN F. BUSCH, OF MILLVALE, PA., ASSIGNOR TO ARMSTRONG CORK COMPANY, OF PITTSBURG, PA., A CORPORATION OF PENNSYLVANIA.

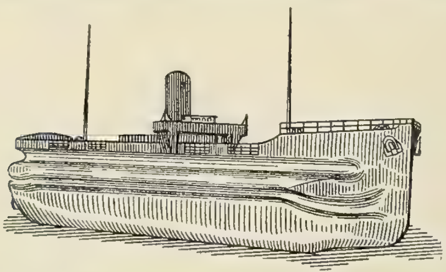
Claim 1.—A ring buoy comprising an annular-body portion of uncovered buoyant material, a peripheral metallic band surrounding the body portion and a plurality of transversely encircling bands. Four claims.

913,951. PROPELLER. FRED. J. GOWING, OF SACKET HARBOR, N. Y., ASSIGNOR OF ONE-HALF TO JEROME B. ROSEBOOM, OF NOGALES, ARIZONA TERRITORY.

Claim.—A two-blade propeller, comprising a central hub, and a pair of oppositely disposed concaved blades, the said blades having a long, straight cutting edge extending at right angles to and flush or in the same plane with one end of said hub, and having a width greater than the length of said hub for a distance equal to the length of said cutting edges, the concavity of said blades gradually increasing from at or near the tips thereof to the points where they are joined to the hub. One claim.

913,973. NAVIGABLE VESSEL. WILLIAM PETERSEN, OF GOSFORTH, ENGLAND, ASSIGNOR TO THE MONITOR SHIPPING CORPORATION COMPANY, LTD., OF NEWCASTLE-UPON-TYNE.

Claim 1.—A vessel having its sides recessed, with a groove extending over the greater part of the vessel's length with a vertical breadth measured parallel to the frame, approximately four or five times greater than the depth of groove measured at right angles to the frame, such



groove being practically parallel with the load water line, and being below the water line, and having the upper and lower edges of practically similar radii merging into the normal contour of the submerged vessel above and below such groove. Eight claims.

914,230. SHIP-VENTILATOR AND CONNECTIONS THERETO. EDWIN ORLANDO BLACKWELL, OF WYNYARD, TASMANIA, AUSTRALIA.

Claim 7.—The combination of decks having openings of different sizes therein, said openings being in line with each other, ventilator tubing having sections of different sizes secured to said decks around said openings, an opening being left around the top of each tube except the highest one, movable plates for closing said openings, means for moving said plates, and stops to limit the upward movement of said plates. Twelve claims.

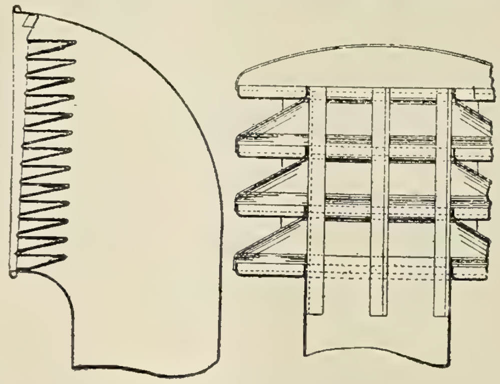
British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

22,139. OPTICAL INSTRUMENTS. F. C. SHIPP AND G. HONEYBALL, IPSWICH.

A peep-tube for enabling an object to be distinctly seen in foggy weather without looking in a direct line comprises a long telescopic or other tube provided at the end directed towards the object with a source of light, and at the other end with an inclined mirror in which the reflection of the object is seen by the observer. A glass may be fitted to prevent fog from passing through the tube, which is attached by hooks, etc., to the ship, vehicle, etc., upon which it is used. If desired, the tube may be jointed, intermediate mirrors and lenses being provided at the joints.

22,366. VENTILATION. W. R. LAWSON, TOTTENHAM, MIDDLESEX.

Ships' ventilators are provided with fixed louvres carrying horizontal perforated plates which arrest the passage of rain and sparks. In the



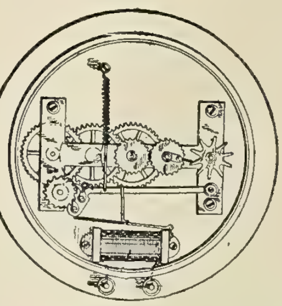
turret type of ventilator the circular louvres and the channel-section perforated plates are riveted to angle-irons which slide in the lower pipe.

22,423. LAMPS. L. C. H. R. EILBERTSEN, NEWCASTLE-ON-TYNE.

Signal lamps are constructed so as to signal to a ship's officer whether or not the rudder has been turned to the position desired. The lamp comprises an outer casing, which is provided with two vertical slots, and is connected by lugs or stays to a fixed part of the steering gear. Within the outer casing revolves a frame fitted on the sides with two sets of alternate green and red glasses, parts of the glasses being obscured. When the rudder is parallel to the keel no light is shown, but the frame is fixed to the steering gear by means of a projecting spindle, and, when the rudder is turned, the red or green lights are brought opposite to the two slots in the outer casing, and two red or green lights are seen, according to the direction in which the rudder is turned, and the area of light seen depends on the extent of the turn.

22,473. SHIPS' LOGS. E. V. H. RIZZO, WESTMINSTER.

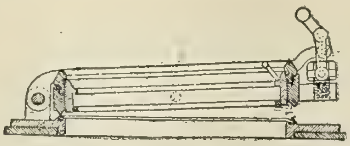
Relates to an improvement upon an electric ship's log. The armature of the electro-magnet when attracted puts tension on a spring which, when the circuit is broken, actuates the registering mechanism. This



mechanism consists of a train of geared-down wheels with hands attached to the spindles of wheels, which indicate tenths of knots, knots and hundreds of knots, respectively. The make and break is actuated by a rolling mechanism bearing on the disk, which has a conducting sector.

23,132. SHIPS' CABIN LIGHTS. W. T. M. FOGGIN, MORPETH, NORTHUMBERLAND.

Cabin and deck lights, of the type wherein the glass-containng frame is rotatable about a diametric axis on pins and is provided with a hinged locking ring, are constructed with the inner face of the locking ring



and outer face of the frame as parts of spherical surfaces. A special toggle lever fastening is provided, which allows sufficient movement of the ring to enable the frame to rotate. The glass frame may be mounted in a swinging frame, with rubber rings between the bearing surface, or the frame may be mounted in a fixed frame.

International Marine Engineering

JULY, 1909.

THE SHIPBUILDING AND ENGINEERING COMPANY OF AKERS MEKANISKE VERKSTED.

BY A. GUNDERSEN.

This company was established in 1842, and originally employed only a few men in a little workshop on the bank of the Akers River, near the city of Kristiania, Norway, from which river the company derived its name. In 1854 it was decided by its three owners (Messrs. Steenstrup, Schiött & Dybwad) to form a stock company and to move the works to the water front of the city of Kristiania, and to establish a shipbuilding yard in connection with the new and improved works, and also to change the motive power from water to steam. In the latter part of the same year they undertook to build their first steamer, which also was the first steam vessel built in Norway entirely of domestic make, as all the machinery parts were cast, forged and machined at the new works. From this unpretentious beginning grew gradually the present large company.

Up to 1867 the establishment had built and delivered forty steamers and ninety-nine engines. The subject of drydocks had by this time received little attention, and as the docking of ships is an indispensable part of their up-keep, it was decided in 1871 to build a graving drydock of dimensions to correspond with the demands of the port. The adjoining property was bought, work commenced, and the first vessel docked in 1874. Since then thousands of vessels have been docked and repaired in it, and the expectation of a profitable addition to the works has been fulfilled.

Up to the 1st of May, 1892, in which year the establishment celebrated its fiftieth year of existence, having built and delivered 137 steamers and 347 steam engines with boilers and auxiliaries, the attention of the firm had, on account of room and facilities, been directed principally to the building and repairing of smaller passenger and cargo steamers, and also to the building of steam whalers, of which the firm made a specialty, building a large number for Japan, England and America. In 1904 the desirability of improved and enlarged facilities was again considered by the board of directors, in order to meet the demands of the country for the building of larger vessels. Hitherto it could not be said that Norway's shipbuilding industry had kept up with the demands for larger vessels, and the many scattered shipyards in the country did not attempt to compete with other countries in the building of larger vessels. The result of the discussion by the board of directors in reference to enlarged facilities was an application to the government for adjoining land on which to extend the shipbuilding yard, and by a special act of the "Storting" the application was granted, and the work of enlarging and improving the plant commenced in 1906. It will thus be seen that the Akers Mekaniske Verksted has made successive extensions to meet a steadily increasing business, until now the plant occupies an area of about 8 acres with a waterfront of 1,000 feet.

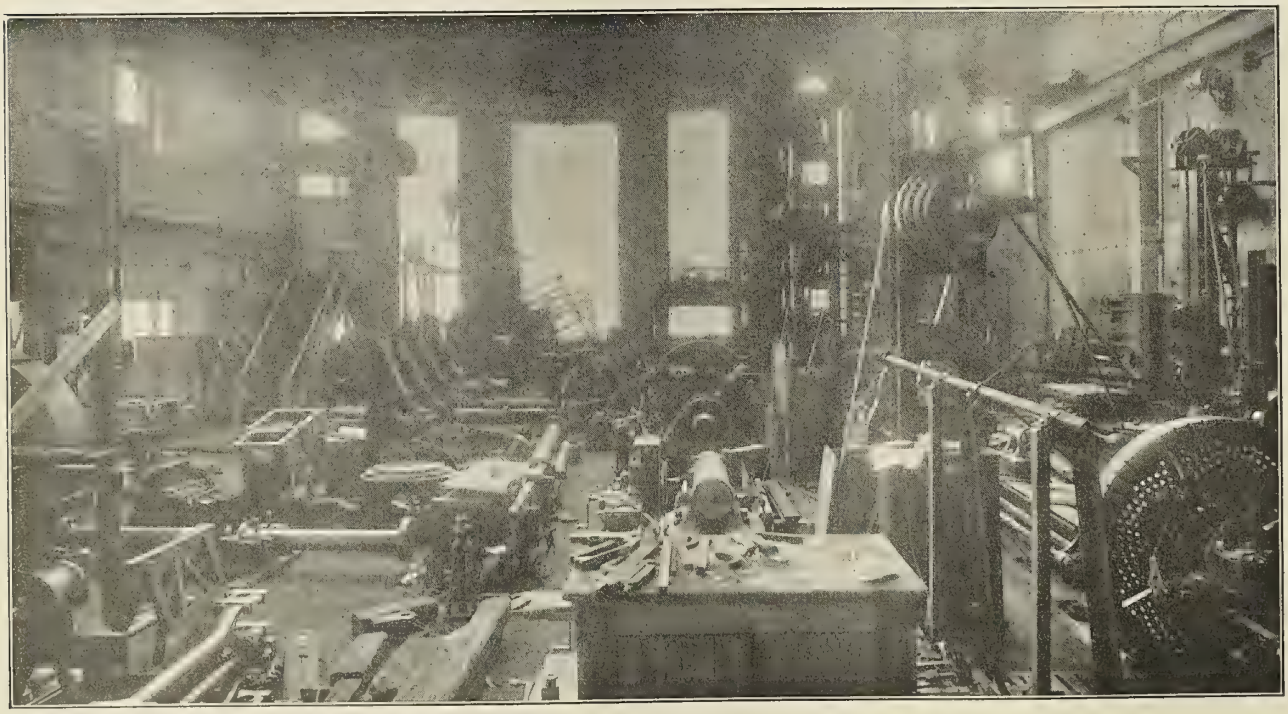
GENERAL VIEW OF AKERS MEKANISKE VERKSTED FROM THE WATER.

In the last two years the motive power has been changed from steam to electricity, and Akers Mekaniske Verksted is

VIEW IN THE SHIPYARD.

perhaps at present one of the few shipyards in the world in which the motors are driven by electric current produced at a waterfall. The Kykkelsrud power station belongs to a private company, and is located on the bank of the River Glommen, about 50 miles from the city of Kristiania. From the power station the current, at 50,000 volts, is transmitted to the city, and transformed to a lower voltage at different stations and used for power and light throughout the city. The voltage, as the current enters the establishment, is 5,000, and in a special fireproof room, in which the transformers are located, the current is further reduced to 230 volts for power and to 110 volts for lighting. All the large tools in the different departments are driven by separate motors, and the smaller tools in groups from electrically-driven shafting.

From the plan of the works it will be seen that the shipbuilding yard now has five building berths, ranging in length from 490 feet to 150 feet, with plenty of water in front of them, and a bay large enough so that the vessels at launching do not have to be checked, a tugboat being sufficient to pick them up and bring them back to the works. The building berths have all necessary derrick cranes and winches for handling the materials, and the large berth is fitted with a skeleton steel frame structure on both sides of the berth 410 feet long, with I-beam runways on top, about 65 feet from the



VIEW IN THE MACHINE SHOP.

ground, on which a trolley hoist is operated by electricity, with a lifting capacity of 6,000 pounds, a traveling speed of 200 feet per minute and a hoisting speed of 100 feet per minute.

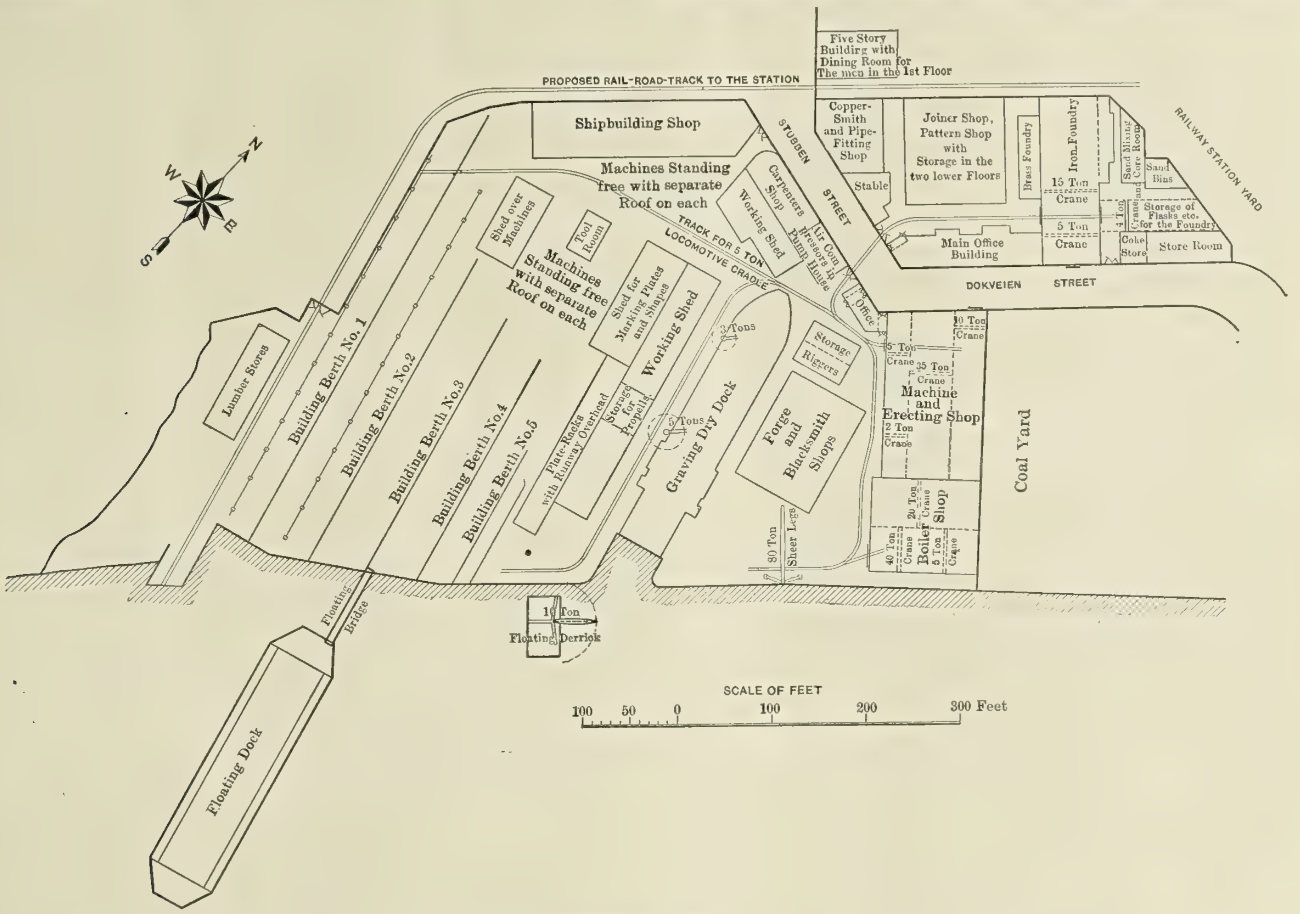
At the end of the building berths are located all the ship building tools, such as punches, shears, drills, countersinkers, beam benders, plate bending rolls, etc. The plate and angle furnaces, with bending slabs, garboard bender, scrieve-board, etc., are located in the building marked shipbuilding shop, with the mold loft in the second story of the same building.

For transportation of materials and articles between the different departments a wide gear system of rails is laid throughout the plant, on which a 5-ton steam locomotive crane is operated.

Lifting capacity about 2,200 tons dead weight.

The dock is provided with five centrifugal pumps, driven by electric motors, and four winches for handling and hoisting purposes, and it is in every respect of modern design and construction. The bottom of the dock has five independent pontoons bolted to the sides, and, as will be seen, the width is large enough to allow increasing the length whenever the demands of the port require it.

The Chicago Pneumatic Tool Company's system of air compressors is employed, and located as indicated on the plan, with pipes leading to all the different shops. One of the compressors is driven by steam and the other by electricity. There are also in use about 110 tools of the Chicago Pneumatic Tool



PLAN OF THE WORKS.

The graving drydock, previously mentioned, is of the following dimensions:

	Feet.
Length on top and bottom	281
Width on top	55
Width on bottom	38
Draft of water over sill	13

The pumping machinery consists of two 15-inch steam centrifugal pumps and two 6-inch pumps for drainage, driven by electricity, all of which are located at the end of the dock.

The floating drydock anchored in front of the building berths is new this year, having been built by William Hamilton & Company, Port Glasgow, Scotland, and is of the following dimensions:

	Feet.	Inches.
Length over outriggers	300	..
Length over pontoons	240	4½
Width outside	69	1½
Width inside at top of pontoons	55	..
Draft of water over keel-blocks 4 feet high at normal water-mark	15	..

Company's make, compressed air being extensively used in the shipbuilding yard for drilling, reaming, calking and riveting.

The carpenter shop is located next to the shipyard, in the same building as the dock pumps and air compressors, and is provided with the usual machine tools for rapid execution of the work.

The machine and erecting shops are partially steel and partially brick, 165 feet long and 100 feet wide, with three bays. The roof construction provides an ample supply of light in addition to the side and end windows. The three bays are divided from each other by two rows of steel columns, giving easy communication from one to the other. The west bay is fitted with a gallery throughout the length, on which a large number of smaller tools are located, and there are traveling cranes both under and over the gallery. The center bay, where the heavy tools are located, is provided with a 35-ton electric traveling crane with a height of 30 feet above the floor; this center bay is also used as an erecting shop, the entire ground floor being paved with wooden blocks on end. In the east bay are located all the medium-size tools. This

is also provided with an electric traveling crane of 10 tons, at the same height from the floor as that in the center bay, for transportation of weights from one machine to the other. The machine shop building is new and modern in every respect, containing tools of the latest design and construction, built in Norway, the United States, Great Britain and Germany.

The boiler department adjoins the machine shop, and will be, when the new building is erected, a continuation of the machine-shop building and similar in construction, but without a gallery. The present boiler shop is provided with a 40 and a 20-ton electric traveling crane, running on beams at right angles to the cranes in the machine shop. Among the tools in this shop may be mentioned a large hydraulic riveting machine and a vertical plate bending machine, capable of bending plates 12 feet 6 inches in width and up to a thickness of 1¾ inches.

On the quay alongside the boiler shop is a set of 80-ton sheer legs, and a floating derrick with a capacity of 10 tons for handling and transporting the lighter weights between vessels and the quay.

The new forge and blacksmith shops will be located between the machine shop and the graving drydock in a single building, 115 feet long and 90 feet wide, and will be equipped with three steam hammers served by three jib cranes. The waste gases from the forge furnaces will be utilized to heat the feed-water for the boilers, and the exhaust steam from the hammers will be utilized for heating the machine and boiler shops during the cold season of the year. The blacksmith fires will be located along the side walls, and the air blast for the furnaces and fires will be provided by a fan driven by an electric motor.

The main offices are located on the opposite side of the street from the shipyard and machine shop, in a two-story and basement brick building, and incorporated with them are the drawing offices, where the ships and machinery are first designed, and where afterwards models and working drawings are prepared.

The foundries, joiner and pattern shops, pipe fitting and coppersmith shop, stables, storerooms, etc., are located on the office side of the street. The iron foundry is equipped with two Krigars cupolas, located on the east side of the building, and the blast is provided by a Root blower, driven by a 35-horsepower electric motor. The building is of steel frame work with brick filling, and is 172 feet long and 66 feet wide, with jib cranes at the sides and two electric traveling cranes operated on runways on top of the columns 23 feet from the ground. The brass foundry is located on the west side of the iron foundry, and on the east side of the same the sand bins, with mixing and core-making machines, are located, all driven by an electric motor as well as an open place for storing of pig and scrap iron and articles for use in the foundry.

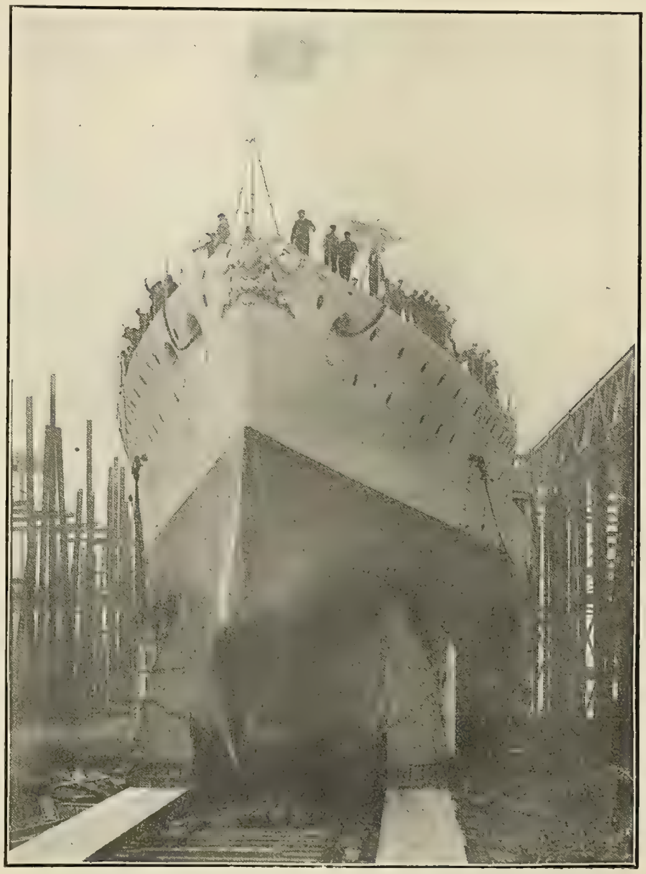
In the large three-story and attic fireproof building back of the office building the two lower floors are used for storage of materials and manufactured articles, and on the third floor are the joiner and pattern shops, equipped with modern woodworking machinery. In the attic is a well-arranged storage for patterns, and in the southwestern corner of this building is a large electric freight elevator for transporting the heavier articles up and down. The pipe fitting and coppersmith shops front on the street as well as the stable building, with living quarters for the stableman and janitor in the second story.

From the foregoing it will be understood that the works are to a great extent self-contained, as not only are ships built here but also the engines and boilers for propelling them, and all the various items of equipment and fittings required in the construction, including joinery, cabinet work and upholstery.

Up to the present time 286 hulls have been built and 572 marine engines with boilers, etc., including those under construction, of which the largest vessels have been of about 2,000 tons dead-weight capacity and the largest engines of about 2,000 indicated horsepower.

The art of shipbuilding in Norway has advanced of late years, and the products are comparable with those of other nations, but the cost and time of production of large-size vessels are perhaps greater than in other countries on account of the lack of materials, facilities to handle the heavier parts and the increased demand for skilled labor. With regard to labor economy, most of the different methods of inducing workmen to exert their full power have been tried, and the piece-work system is now extensively adopted, having proved very successful; but the premium system has not apparently been very widely used. The universal system of marking plates and shapes instead of making templets has also found its way to some of the Norwegian shipyards, and it must be stated, in justice to the men, that some of them are very good at it.

It is a well-known fact that the shipowners in Norway who have wanted larger ships have up to the present time, with a few exceptions, placed their orders elsewhere, as the Norwegian shipbuilding firms have not before seen their way clear to increase the productive capacity of their establishments to meet the demands for building larger vessels. This has been a great detriment to the Norwegian shipbuilding industry in the past, and the government has not assisted the home industry by giving a shipbuilding subsidy to encourage the undertaking in order to keep the business at home; but in spite of this, a few ship and engine-building firms in Norway, besides the one just described, have recently made improvements to meet the demands, and it is to be hoped that the nation will stand by them, and grant privileges for a few years, to assist in the undertaking of building larger vessels at home.



LAUNCH OF THE SAO PAULO.

Launch of the Sao Paulo.

The Brazilian battleship *Sao Paulo* was launched on April 19 from the yards of Messrs. Vickers Sons & Maxim, at Barrow-in-Furness. The *Sao Palo* is one of three first-class battleships now building in England for Brazil. She is 500 feet long between perpendiculars, with a beam of 83 feet and a displacement on a draft of 25 feet of about 19,500 tons. The designed indicated horsepower is 23,500, and the speed 21 knots. Her armament consists of twelve 12-inch guns mounted in pairs in six turrets, four of which are on the center line of the ship. The secondary armament includes twenty-two 4.7-inch rapid-fire guns and eight 3-pounders. The heaviest armor is 9 inches thick, extending from well below the water-line to the upper deck. The ship is particularly well protected in the extent and distribution of her armor. Propulsion is by means of two four-cylinder, triple-expansion engines operating at 140 revolutions per minute. Steam is supplied by eighteen Babcock & Wilcox watertube boilers at a pressure of 250 pounds.

SUPERHEATED STEAM IN MARINE WORK.—I.

BY F. J. ROWAN.

INTRODUCTION OF SUPERHEATED STEAM IN MARINE WORK.

Considerable interest attaches to the fact that a large proportion of the experience gained from the use of superheated steam, at the time of its introduction some fifty years ago, was obtained in marine practice. Due to the limited development of boiler construction at that time, the steam pressures used in marine engines were low, and, consequently, the temperatures and range of expansion were low, so that only a moderate amount of superheat could be conveniently applied. This, of course, limited the advantage to be derived from superheating, and left room for a very ready and obvious means of obtaining the same results without superheating, viz.: by increasing the pressure and therefore the temperature of the steam in the boilers. Other considerations, such as the introduction of compound engines, troubles with superheater tubes and troubles with rubbing surfaces of cylinders, piston rods, valves and packings, induced engineers generally to abandon low-pressure superheated steam for high-pressure saturated steam. Nevertheless, engineers were familiarized with the general features of the use of superheated steam, and specially with the fact of the advantage to be derived from hotter, and therefore drier, steam.

There are three ways in which superheaters may be applied, examples of all of them being found in marine work:

1. They can be fitted in the flue space or up-take of boilers, so as to absorb heat from the hot gases after the gases have given up the larger portion of their heat to the boiler surfaces.

2. They may be placed in the boiler, forming really a part of the boiler construction and meeting with the hot gases at an earlier point than is possible with some of those which are placed in the up-takes.

3. They may be an entirely distinct apparatus, constructed with a separate furnace for independent firing.

In early marine practice only the first two methods were employed, the majority of superheaters having been arranged in the up-take or at the base of the funnel. One of the earliest was introduced by Messrs. John Penn & Son, in the P. & O. Company's steamer *Valetta,* and is shown in Fig. 1. The engines were of 260 nominal horsepower, and the boilers were of the "box" type, of Messrs. Lamb & Summers' design, the superheaters being placed in the up-take outside the ends of the vertical flues, which in Lamb & Summers' arrangement took the place of the usual horizontal flue tubes. The superheater was formed of horizontal wrought iron tubes, 2 inches inside diameter and 6 feet 3 inches long, arranged in two bundles or groups, each group consisting of forty-four tubes. These were placed in vertical rows, with clear spaces between the rows horizontally for access to the boiler flues for cleaning or brushing. The tubes were fixed at the ends into three flat chambers, made of wrought iron, welded up at the corners and each closed with a single flange joint. Steam from the boiler was admitted to the center chamber through a stop-valve, and was taken off from the end chambers by other stop valves communicating with the steam pipes to the engine. The total area of superheating surface, including the wrought iron chambers, was 374 square feet in each of the two boilers. The pressure of steam then used was 20 pounds

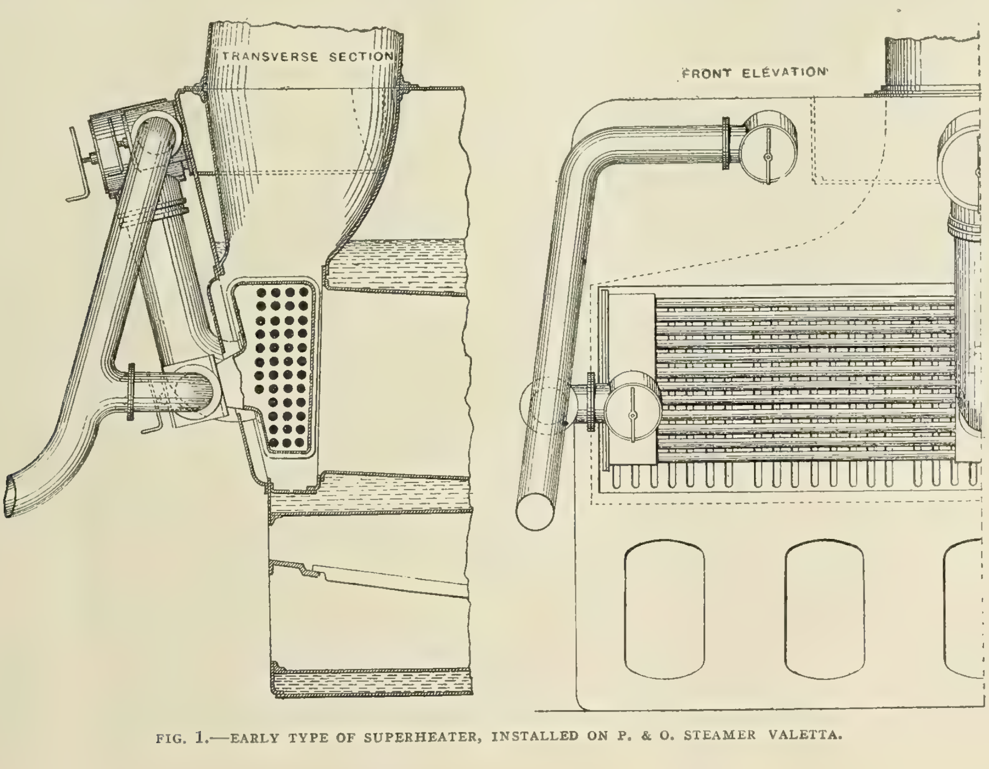


FIG. 1.—EARLY TYPE OF SUPERHEATER, INSTALLED ON P. & O. STEAMER VALETTA.

per square inch, and the steam was superheated 100 degrees, or from 260 degrees F. up to 360 or 370 degrees F.

A different construction of the early up-take superheater is shown in Fig. 2, which was that of Patridge, fitted in H. M. S. *Dee*, in the R. M. S. *Tyne*, and in the Cunard Company's steamer *Persia*. A modification of it was introduced into the steamship *Great Eastern*. This superheater consisted of a cylinder filled with vertical tubes, and placed vertically over the up-take, resting on the steam chest at the base of the funnel. The hot gases passed up through the tubes and through an annular space surrounding the cylinder between it and the chimney; and the steam was passed across the cylinder and over a vertical baffle plate in the center, steam pipes being arranged on each side of the cylinder at its base. In the case of the *Great Eastern* the superheater, constructed by Boulton & Watt, had an oblong form, and the chambers containing the vertical tubes were placed in a casing of similar form, which constituted the base of the chimney. This is shown in plan in Fig. 3. The same firm introduced a more

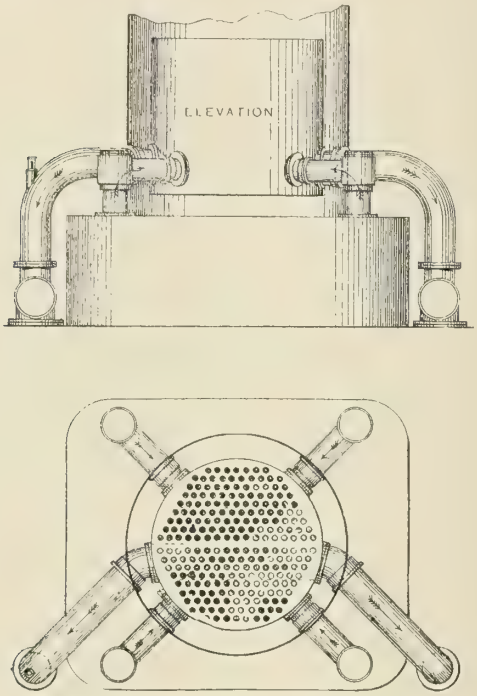


FIG. 2.—PATRIDGE UP-TAKE SUPERHEATER.

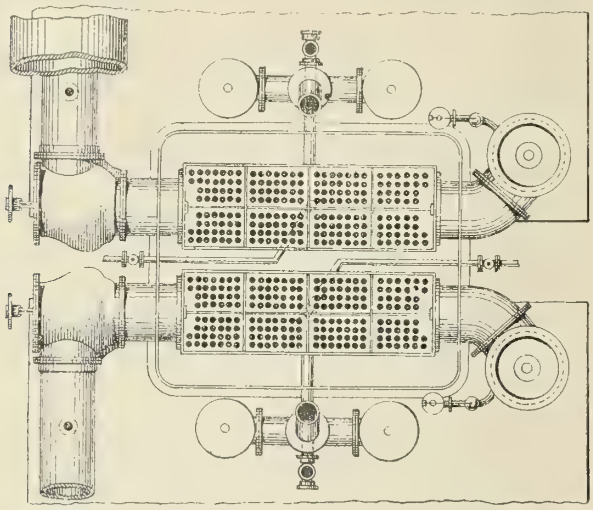


FIG. 3.—SUPERHEATER USED ON THE GREAT EASTERN.

simple form of superheater in the Holyhead steam packets. In these the lower part of the funnel was surrounded by a steam casing, which was divided radially by six partitions, the steam being caused to alternately ascend and descend in these until it passed over all the surface which was exposed to the heat from the chimney gases.

Fig. 4 shows another form of up-take superheater which was fitted in the steamer *Oleg* by Messrs. R. Napier & Sons. It consisted of horizontal steam tubes, 2 inches outside diameter, 5 feet 6 inches long, fastened in flat, stayed boxes or headers, and placed in an oblong casing forming the root of the funnel.

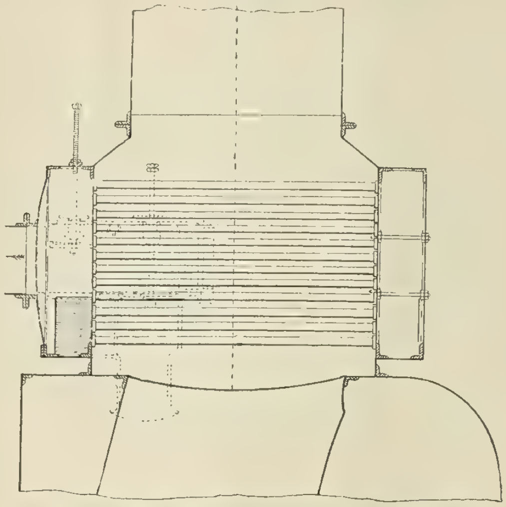


FIG. 4.—AN EARLY FORM OF UP-TAKE SUPERHEATER.

Beardmore's superheater, Fig. 5, is an example of the construction as formerly arranged, in which the superheater forms a part of the boiler. In that instance no special stop valves were employed.

An entirely different arrangement, by which a much higher degree of superheat was obtained, is shown in Figs. 6 and 7. This was Parson & Pilgrim's superheater, which was placed in the furnaces of marine boilers. A steam pipe, common to two furnaces, was led from the steam space to a position between the furnace doors, where it branched into two horizontal pipes, one of which entered each furnace below the fire-bars and passed nearly to the back of the grate. Two saddle-shaped pipes then rose from the horizontal pipe into the combustion space, and the steam passed through them to a return

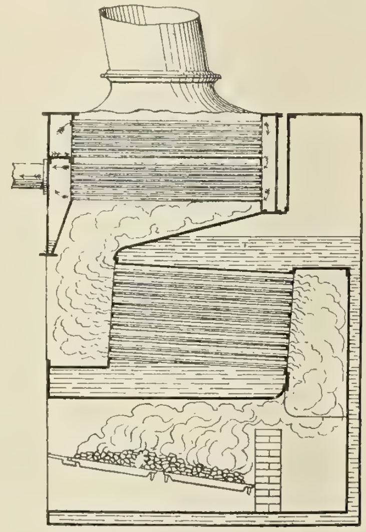


FIG. 5.—OLD-STYLE BEARDMORE SUPERHEATER.

horizontal pipe on the opposite side of the ash-pit. The arched pipes frequently became red-hot, so that steam of 20 pounds per square inch pressure, or 264 degrees F. temperature, was found to have attained a temperature of from 484 degrees to 540 degrees F. After trial in a stationary boiler at Woolwich Arsenal, this superheater was applied to the boilers of vessels in Waterman's Steam Packet Company on the Thames and in H. M. steam tug *Bustler*.

Some other plans were proposed and tried in marine work, but accounts of their action have not been preserved. One deserving of notice, however, is that of Messrs. Wethered, on account of their endeavor to control the steam temperature by mixing saturated with superheated steam. Their superheater is said to have consisted of a coil of pipes, having about 3 square feet of surface per nominal horsepower, placed either in the combustion space or in the heating flues of the boiler; but in practice modifications of that arrangement were adopted, so that the superheaters fitted in the vessels of the P. & O. Company and in H. M. S. *Dee* were included in the number of those using Wethered's system,

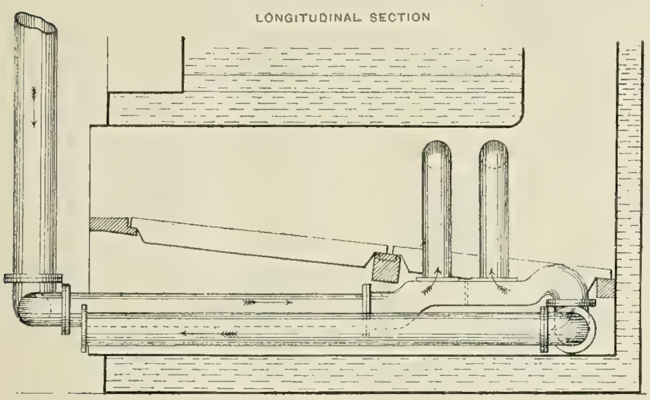


FIG. 6.

although the latter was also claimed as having been fitted with Patridge's superheater. Sir John Durston has, however, recorded that superheaters were brought to the notice of the Admiralty by Mr. Wethered, and trials were made in H. M. S. *Black Eagle* in 1856, which showed considerable economy in fuel in their favor. These and further trials resulted in their coming into general use about the same time as surface condensers; but a further step was made in 1860-63 by the introduction of compound engines with surface condensers and superheaters in H. M. S. *Constance,* a frigate of 500 nominal horsepower, which was fitted and tried in 1863. M. Felix Godard (Trans. Inst. N. A., 1908) states that the French navy tried superheated steam in one of their earliest protected cruisers.

Vessels belonging to the Russian Steam Navigation Company were included among those fitted with superheaters by John Penn & Son, along with others belonging to the P. & O. Company, and the saving claimed in several instances ranged from 23 to 34 percent.

In America trials were made in 1854, under the direction of Mr. B. F. Isherwood, in the steamer *Joseph Johnson,* with a mixture of superheated and saturated steam, and the results reported were extremely favorable. At a later date—1862-1864—the United States government instituted more thorough experiments, under Isherwood's direction, in the Bay line of steamers in Baltimore, principally in the *Eutaw,* and although an average gain in power was obtained of 18 to 20 percent it appears that the superheater pipes must have been seriously overheated at times, and the deterioration of these coils caused the trials to result in an unfavorable opinion of the practicability of superheating.

THEORETICAL CONSIDERATIONS.

The principal features of superheated steam may be summarized as follows: (1) Superheated steam is independent of pressure (that is to say, saturated steam of any pressure may be superheated) and admits of variation in temperature, while the pressure remains constant; (2) the temperature of superheated steam may be reduced without condensation taking place; (3) superheated steam is greater in volume than saturated steam of the same weight, but 1 pound of superheated steam contains more heat than 1 pound of saturated steam; (4) superheated steam practically follows the laws of a perfect gas.

To illustrate the relation which heat bears to the production of superheated steam, any table of the properties of saturated steam will show that such steam at a total pressure of 100 pounds per square inch has a temperature of 327.9 degrees F., and that the total heat of evaporation of 1 pound at that pressure is about 1,181 B. T. U., representing the sensible and latent heat employed. To increase the temperature of that 1 pound of steam by superheating 200 degrees F. at constant

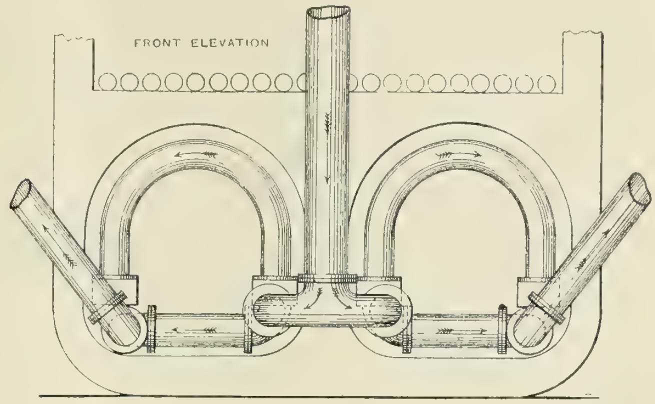


FIG. 7.

pressure, the addition of only $200 \times .520$ or 104 B. T. U. is required. The full value of this heat, as so applied, can be estimated only by its effect on the complete system, including both boiler and engine, but a rough comparison may be made by estimating the saving in coal at the boiler. The following example is said to correspond fairly with actual results: Assuming that a boiler evaporates 10,000 pounds of water per hour into steam of 165 pounds working pressure, from water at 64 degrees F., this requires 1,250 pounds of coal, taking 8 pounds of water per pound of coal as the rate of evaporation. This quantity of steam would supply an engine of, say, 450 indicated horsepower, using 22 pounds per indicated horsepower-hour; 70 percent of the saturated steam is taken as doing useful work and 30 percent as wasted by condensation, etc. If the steam were superheated 200 degrees F., cylinder condensation and other troubles would be practically avoided, and the volume of each pound of steam would be increased by 25 percent. Taking this figure to represent the gain, the same horsepower could be developed by $\frac{10,000}{1.25} = 8,000$ pounds steam when superheated. At the same rate of evaporation per pound of coal 1,000 pounds of coal per hour would be required, plus the quantity required to superheat the steam. This would be

$$\frac{200 \times .541 \times 8,000}{8 \times (1,196 - 32)} = 93 \text{ pounds per hour.}$$

Thus the saving in coal works out at $1,250 - 1,093 = 157$ pounds, or 12.56 percent.

The advantage to be derived from superheating is in this

illustration supposed to depend solely upon the increased volume of the steam, but that is not strictly correct. It is now agreed that the thermodynamic advantage is comparatively small, and that practically the whole benefit from superheating is due to the prevention of cylinder condensation and leakage.

Calculations founded upon the *pv* diagram are unsatisfactory, because of uncertainty as to the proper index of the adiabatic expansion curve; and the theoretical conditions represented on the $\Theta\ \Phi$ diagram are almost impossible of realization. The true test of the advantage of superheating is that of a heat balance as applied to the entire system, including boiler, superheater and engine, or of thermal units per horsepower-minute or hour.

In all calculations connected with the use of superheated steam, or the capacity of superheaters, the specific heat of the steam is a most important factor. Regnault's figure of 0.48 was for years relied upon as being a correct mean value, but investigations carried out in Germany by Knoblauch and Jakob, and in America by Drs. Thomas, Heck and others, have shown that there is a considerable variation in the specific heat with altered conditions of pressure and temperature. It is found that, generally, the value of the specific heat decreases for any *pressure* as the temperature rises, and increases for any given *temperature* as the pressure rises.

In Fig. 7 a diagram is reproduced showing isobaric curves of the specific heat at constant pressure of superheated steam, derived from Knoblauch and Jakob's experiments, and the following table gives the mean specific heat for superheat from saturation temperature t to t_s degrees. The figures are given in French and British units:

MEAN SPECIFIC HEAT FOR SUPERHEATS FROM SATURATION TEMPERATURE t TO t_s DEGREES.

p. in kg. pr sq. cm.		1	2	4	6	8	10	12	14	16	18	20
p in lbs. per sq. inch.		14	28	57	85	114	142	170	199	227	256	284
t in dgs. C.		99	120	143	158	169	179	187	194	200	206	211
t in dgs. F.		210	248	289	317	336	354	369	381	392	403	412
ts Degrees Fah.	Cent.											
212	100	.463	....	.....	.....	.....	.....	.....	.....	.....	.....	.....
312	150	0.462	0.478	0.515	.....	.....	.....	.....	.....	.....	.....	.....
392	200	0.462	0.475	0.502	0.530	0.560	0.597	0.635	0.677	(0.751)	.....	.....
482	250	0.463	0.474	0.495	0.511	0.532	0.552	0.570	0.588	0.609	0.635	0.664
572	300	0.464	0.475	0.492	0.505	0.517	0.530	0.541	0.550	0.561	0.572	0.585
662	350	0.468	0.477	0.492	0.503	0.512	0.522	0.529	0.536	0.543	0.550	0.557
752	400	0.473	0.481	0.494	0.504	0.512	0.520	0.526	0.531	0.537	0.542	0.547

Figures have been published by Thomas in America and by Mollier in Germany which do not materially differ from those of Knoblauch and Jakob. Mollier gives the following formula for the specific heat for any degree of superheat:

$$(C_p)^t{}_{t'} = \frac{H - H'}{t - t'}$$

where H = the total heat in the steam at point of superheat, H' = the total heat in the steam at point of saturation, and t and t' are the respective total temperatures.

From a recent research by Dr. Harvey N. Davis, of Cambridge, Mass., on the total heat of saturated steam, it appears that Regnault's figures and formula are not correct, due probably to the presence of unobserved moisture in his experiments. New tables of total heat, specific volume, etc., of steam are therefore to appear, but meantime engineering calculations will not be seriously affected by the use of the old values in existing steam tables.

Estimates of theoretical economy, due to the use of superheated steam, vary greatly according to the basis upon which economy is reckoned. There may be, and have been, for instance, estimates of the quantity of steam used by an engine showing a saving in *steam*, due to superheating of 14 percent and upwards, according to the kind of engine—reciprocating or turbine, high speed, etc.—employed. The saving in *heat* from the point of view of preventing initial condensation by superheat may be only some 3.5 percent; but the total saving in heat is a much larger question, and includes savings in generating steam, preventing condensation in pipes, cylinders and valves and diminishing leakage, all of which can be estimated only from the performance of the whole apparatus. The saving in coal cannot be directly estimated from the superheating, apart from the use of the steam, as has been remarked. In the case of steam turbines the use of superheated steam has been proved to effect a reduction of fluid friction, and this is an element of economy in their working.

The following two tables show percentage reductions in steam consumption, due to superheating, which have been obtained in turbines and in reciprocating engines in land

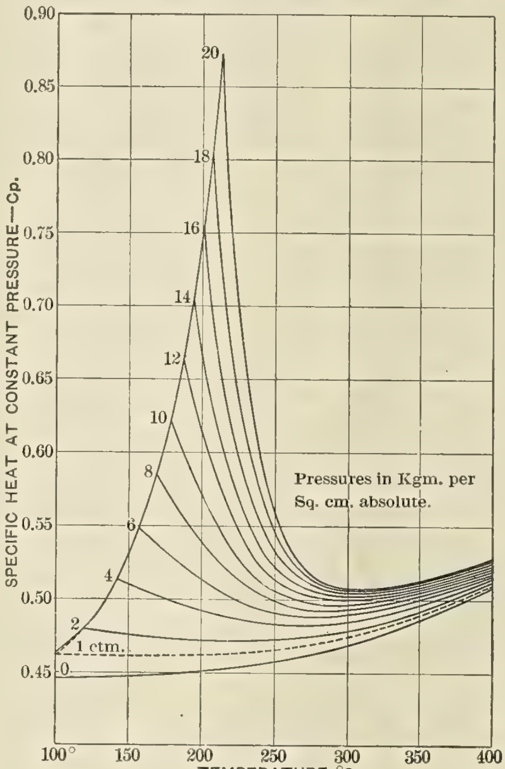


FIG. 7.

installations. These were carefully collected by Mr. R. M. Neilson, and given to the Cleveland Institute of Engineers. Of course, it is necessary to know the details of each test in order to be able properly to understand the relative value of the reduction of steam consumption in each case.

TABLE A.

REDUCTION IN THE STEAM CONSUMPTION OF TURBINES DUE TO THE USE OF SUPERHEATED STEAM.

Degrees Fahrenheit of superheat	13	50	60	66	70	84	100	140	150	200	260
Percentage reduction of steam consumption	6.1	8.0	5.4	12 1	7.5	7.7	14.0	12.6	19.′	23.0	24.5
Percentage reduction per degree Fahrenheit	0.47	0.16	0.09	0.18	0.11	0.09	0.14	0.09	0.13	0.115	0.09

TABLE B.

REDUCTION IN STEAM CONSUMPTION OF RECIPROCATING ENGINES.

Degrees Fahrenheit of superheat	31	40	50	100	150	216	225	225	440
Percentage reduction of steam consumption	7.86	8.65	12.00	20.55	13.00	36.4	33.7	33.1	30.9
Percentage reduction per degree Fahrenheit	0.25	0.22	0.24	0.20	0.09	0.17	0.15	0.15	0.07

In marine practice, from the nature of the service—except in the case of warships or in specially observed trials—results are not collected with the same care as on land, and hence economies are more roughly estimated. The total expenditure of coal, or the radius of action, is usually the test applied. So far, superheated steam has been introduced only to a small extent with the use of turbines on board ship, but there is no reason why its advantages with turbines on land should not be realized in marine work also. There are some successful examples which will be noted later; but the larger number of steamships hitherto fitted with superheaters have reciprocating engines.

On its first introduction, about fifty years ago, it was proposed that superheated steam should be used in a mixture with a certain proportion of saturated steam, and it is interesting to find this proposal revived in a discussion at the Institution of Naval Architects last year. The advantages of this mixture were supposed to be twofold, viz.: to effect control of the temperature of the steam admitted to the engine, and to provide lubrication of the rubbing surfaces by the condensation of a small quantity of the steam. The plan of Messrs. Wethered, which depended upon this mixture, was, however, to a great extent deprived of its exclusive value by the discovery that when a temperature of not over 360 degrees F. was used no admixture of saturated steam was necessary. To-day the proposal to use this mixture seems to be with a view to control temperature at the superheater, but it has been pointed out that spraying water into the superheater tubes is more efficacious. The former difficulties of using steam of high superheat in engines and of lubrication have almost entirely disappeared.

INFLUENCE OF THE USE OF SUPERHEATED STEAM ON ENGINE DESIGN.

The main reason for modification in the design of engines to use superheated steam is that the effects of high temperature must be provided for. With a so-called "moderate" superheat, or about 150 degrees F. at the boiler, which yields about 100 degrees F. at the engine, practically no alteration would be required, but the superheat disappears by the end of the stroke of the high-pressure piston, and if, in a compound engine, it is desired to have superheated steam in the low-pressure cylinder, the high-pressure exhaust steam must be passed through a reheater. It is not difficult to understand that the use of superheated steam has shown that with it there is no advantage to be gained by multiplication of cylinders—a compound or triple-expansion engine providing all that is required for economical working. The real advantages of superheated steam are, however, it is maintained by many, to be obtained only from what is called high superheat, which varies from 200 degrees F. upwards. When that temperature, or even 150 degrees F. at the engine cylinder, is added to the temperature, due to saturated steam of high pressure, a degree of heat is reached which introduces special conditions of expansion, erosion, tenacity and ductility, condition of surface, etc., in the different metals ordinarily employed, and these affect pipes, cylinders, pistons, valves, etc., and also packings and lubricating material.

Generally, as a well-known authority has expressed it, the steam pipes should be of lap welded or drawn iron or steel, with ample provision for expansion, and where there is excess of boiler pressure they should be of smaller diameter than is usual when saturated steam is used. They should be carefully lagged and the flanges should be covered by removable boxes. The cylinders should be designed to allow the parts exposed to the entering superheated steam, the working steam and the exhaust steam to expand independently of each other. Care is required in the selection of the quality of metal for the cylinders; which should have uniformity of thickness, without projections, as far as possible, to favor equality of expansion throughout. The dimensions of the cylinders will be increased if their number is reduced, and the speed of working can be increased with superheated steam. The pistons also require care in making, and should be carefully guided and lubricated directly rather than by mixing oil with the steam. Corliss valves can be used with moderate superheat, but higher degrees require drop-piston valves, or double-beat equilibrium valves working vertically; and no metals should be employed which have a melting point within reach of the steam temperature. The packings of piston rods and valve spindles should be metallic, and lubricating oil should be of the mineral variety, such as is employed in gas engines, in which far higher temperatures are successfully dealt with. Scoring of cylinder surfaces, pistons and piston rods has been found to emanate from the decomposition of unsuitable lubricants, and even trouble with piston rings has been discovered to be due to the same cause. With proper attention to the form and distribution of metal in cylinders, valves, etc., the chances of any of the moving parts seizing are reduced to a minimum, and the friction of the engine will be kept low.

The reduction of leakage and condensation is due to the quality of the steam, and is greatly in favor of the smooth working of the engine; a more even distribution of steam during the stroke is given, and a reduced total weight of steam being used the work of the air pump and condenser is rendered lighter. The advantage reacts even upon the boiler, a reduction in the weight of steam required meaning either fewer boilers or easier firing.

The part of the apparatus which apparently needs the most care is the superheater itself, as it is exposed to the danger of overheating. The methods of construction now in use, and the care taken in arranging the position of the superheater relatively to the temperature of the hot gases reaching it, have, however, greatly discounted that risk, and instances are not wanting of superheater tubes lasting practically as long as the boiler. Marine practice is liable, from more frequent stopping and starting of the engines in some kinds of service, to put a more severe strain upon the superheater as regards fluctuations of temperature than is work on land; but this, as other conditions, can be successfully encountered.

The question of reheaters and jackets would require a large amount of space for its full discussion. Theoretically, it is better to superheat to a high temperature than to a lower one and to use reheaters to carry the necessary superheat to the later stages of the engine or turbine. But practical difficulties with the higher temperature turn the scale in favor of the less perfect method. In fact, in the Schmidt system of using steam of high superheat, the steam is passed through the tubes of a reheater standing in the path of the exhaust from the high-pressure cylinder before it enters the high-pressure cylinder, and thus the temperature of the steam is modified even in that cylinder. With both reciprocating compound engines and with multiple-stage turbines it is common, in land practice, to use reheaters between the cylinders or the stages of expansion. The turbine gains considerably in efficiency by the use of superheated steam, and the steam consumption in some land installations is stated to be reduced 1 percent for every 10 degrees to 12 degrees F. of superheat used, leading to a saving in fuel consumption of about half that amount. The high temperature, however, demands that the clearance over the tips of the blades must be made slightly greater to allow for extra distortion of the cylinder, although this may involve some slight loss by leakage. The discharge angle of the blades is also affected by the coefficient of friction being less with superheated than with saturated steam.

Finally, as to steam jackets, it seems to be settled that it is useless to jacket the high-pressure cylinder, using superheated steam, unless with the waste furnace gases, but that steam

jackets may be used with advantage on the low-pressure cylinder in order to prevent condensation there, if the saturated condition is reached by the steam at any early period in the stroke.

(To be continued.)

SIMPLE METHOD OF PROPELLER DESIGN.

BY CHARLES S. LINCH.

In the design of a propeller wheel there are a number of assumptions to be made, and when data from other ships are at hand it is better to obtain such data from previous work for the purpose of comparison. In the delineation of the propeller wheel these things do not have to be considered, as it is the designer's place to give the draftsman the necessary information, but the knowledge of the necessary steps is of great importance, and hence, before proceeding to describe the methods, we will work out the computations and then proceed to explain the different methods of drawing the blade.

The wheel which we will take as an example is one designed by the writer for a freight and passenger ship. The requirements were as follows: The designed indicated horsepower was 1,989, and it was obtained from computations for the resistance, etc. The speed was 15.5 knots. The revolutions were to be between 86 and 88 per minute.

The developed area of the blade was obtained by first taking a standard elliptic blade with a mean width ratio of .2, and computing the area from this. For example, we know that the mean-width ratio is equal to the mean width divided by the diameter of wheel in feet; and, further, we know that the mean width is equal to the developed area of the blade, divided by the diameter of the wheel, minus the diameter of the hub, and this difference divided by two. From the draft of water aft and by making the proper allowance for immersion of the tip of blade, a diameter of wheel was assumed. The developed area was computed as equal to 19.1 square feet for each blade. The diameter of hub was made equal to 0.24 times the diameter of the wheel. As this wheel was of the built-up type, this gave a hub of ample dimensions.

The apparent slip, taken from the performance of a ship of similar dimensions, equals 10 percent. The true slip was 22 percent; therefore the wake factor was 16 percent. The propeller efficiency was taken at 65 percent and the engine efficiency at 87 percent; therefore the propulsive coefficient is $.87 \times .65$, or 56 percent. The speed of the ship in feet per minute is equal to $\dfrac{15.5 \times 6{,}080}{60}$, or 1,570.15 feet per minute.

Now $1 -$ apparent slip $= 1 - .1 = 0.9$.

$.9PR = 1{,}570.15$, therefore $PR = 1{,}744.6$.

The log of $1{,}744.6 = 3.2416959$.

The log of $(1{,}744.6)^3 = 9.7250877$.

Corresponding number $= 5309900000$.

The log of $60 = 1.7781513$.

The log of $(60)^3 = 5.3344539$.

Corresponding number $= 216000$.

Now, assuming a standard elliptic blade, and that $\dfrac{P}{D} = .76$, we have for the characteristics of the blade:

$A = 0.340.$
$B = 0.569.$
$C = 1.354.$

With width ratio (mean) of 0.2 we have

$A = 0.340 \times 0.2 = .0680.$
$B = 0.569 \times 0.2 = .1138.$
$C = 1.354 \times 0.2 = 2.708.$

Now the propeller power equals $1{,}989 \times 0.56 = 1{,}113.84$; therefore

$$U = \frac{1}{550 \times (60)^3} P^3 R^3 D^2 N (1 - s) (a s A - f B).$$

Substituting and solving for D we have

$$D^2 = \frac{1{,}113.84 \times 550 \times (60)^3}{(1{,}744.6)^3 \times 4 \times .78 (2.74 \times .22 \times 0.068 - 0.016 \times 0.1138)} = 204.27$$

Therefore $D = 14.28$ feet, $\dfrac{D}{P} = 0.76$; therefore $P = 14.28 \div 0.76 = 18.8$ feet. Since the mean-width ratio $= \dfrac{\text{mean width}}{\text{diameter}}$, we have $0.2 = \dfrac{\text{mean width}}{14.28}$; therefore mean width $=$ 2.856 feet, and $2.856 = \dfrac{\text{developed area}}{\dfrac{\text{diameter wheel} - \text{diameter hub}}{2}}$, or

$2.856 = \dfrac{2 \times \text{developed area}}{10.78}$; therefore developed area $=$ 15.39 square feet.

Now $PR = 1{,}744.6$.

$P = 18.8$ feet, say 19 feet, therefore,

$R = 91.7$.

We, therefore, have by computation:

Diameter wheel $= 14.28$ feet.

Pitch wheel $= 18.8$ feet.

Revolutions wheel $= 91.7$.

Developed area $= 15.39$ square feet.

Mean width ratio $= 0.2$.

Mean width $= 2.856$ feet.

Maximum width $= 3.1$ feet.

The wheel as built was 14.5 feet diameter, 19.0 feet pitch.

Developed area $= 15.5$ square feet.

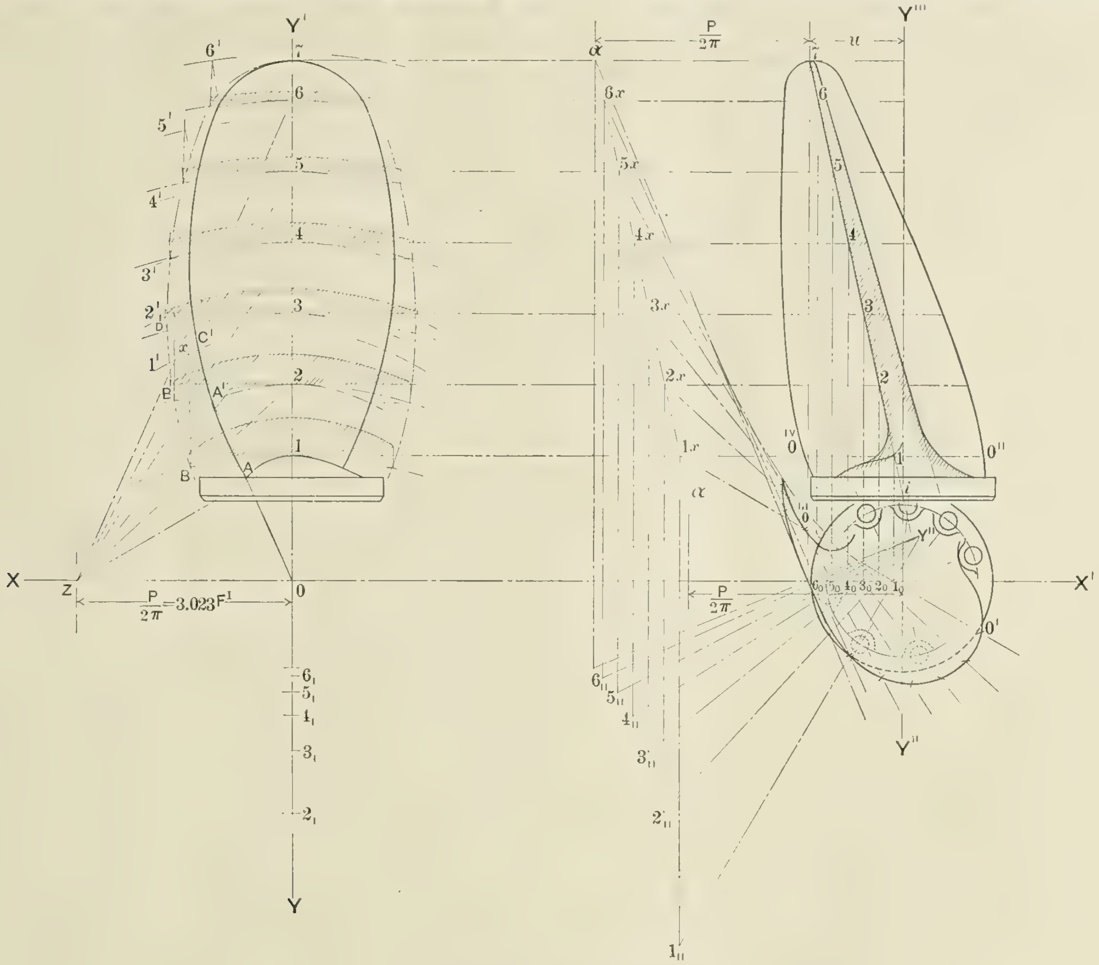
Diameter hub $= 3.5$ feet.

We are now ready to draw the wheel. First draw the line $X X'$ as shaft center, and erect the perpendicular $Y Y'$, intersecting the line $X X'$ at O. Set off on $Y Y'$ the distance O-1 equal to the radius of the hub. Set off on $Y Y'$ O-7 equal to the radius of the wheel. Divide the distance O-7 into any convenient number of parts, and draw through these points horizontal lines parallel to $X X'$. Now place over this much of the drawing a piece of tracing paper, and sketch the outline of developed contour. If we are working from projected area, then this area is to be found and the shape corresponding. We will assume that we have the developed area as a basis. Now, with a standard blade (elliptic) we can divide the vertical distance O-7 on the tracing paper into either tenths or twentieths and compute the widths at these points. These dimensions will be parts of the maximum width, or if not computed we can follow the suggestions of Prof. Durand, namely, describe on one side of the vertical a rectangle of area near the required area, and sketch in free hand the contour.

After this is done, take planimeter readings, and after the area and shape are satisfactory we can measure the widths at the point of intersection of the horizontals 1, 2, 3, 4, etc., with the contour of the blade. We can now remove the tracing paper and transfer these measurements to the drawing.

After these points are properly located, we can run a fair curve through them, and we have now the developed shape of the blade. This then is the 'thwartship view. At a convenient distance we erect another vertical line $Y'' Y'''$. This is to be the fore-and-aft view of blade and hub. We now set off the rake u and through the points 1, 2, 3, 4, etc., we produce the horizontals to intersect the vertical $Y'' Y'''$. After setting off the rake u, we draw a line from this point, intersecting the vertical $Y'' Y'''$ in i, in this case. This is the slope of the generating line. Some blades intersect at the point of intersection of the vertical with the horizontal. Now, from point 7 and point of intersection of $Y'' Y'''$ set off parallel to $X X'$ a distance equal to $P \div 2\pi$, draw through these points a straight line. This line is parallel to the generating line.

Now where the arcs $1B$, $2B'$, $3D'$, etc., intersect the developed contour of the blade, erect perpendiculars intersecting the arcs $1'$, $2'$, $3'$, etc., as at x. From this point of intersection draw a diagonal to the point o, and where this point intersects the circular arc as at A, this point is a point of the projected view. After marking off the points, as above described, a fair curve passed through them gives the boundary of the projected area. We can proceed in the same way for the other side, but, if the blade is symmetrical, about the center line $Y Y'$ we can step the distances off with dividers, or, better still, if the work is done very accurately, we can simply draw the horizontal line, such as $A\ B$, $A'\ B'$, etc. We now have the two views on the thwartship plane. Some prefer to draw in the hub first, but as the hub is of small consideration, it can



LAYOUT OF A PROPELLER BLADE.

From the points 1, 2, 3, 4, etc., let fall verticals intersecting the line $X X'$ in 1_o, 2_o, 3_o, etc. From the points 1_x, 2_x, 3_x, etc., let fall perpendiculars. From the points 1_x, 2_x, 3_x, etc., draw diagonal lines, passing through the points 1_o, 2_o, 3_o, etc.

We then draw the lines $1_o 1_{||}$, $2_o 2_{||}$. These lines are drawn at right angles, respectively, to 1_x, 1_o, 2_x, 2_o, etc.

Now the point of intersection of the verticals dropped from 1_x, 2_x, 3_x, etc., are the radii of the circular area $1B$, $2B'$, $3D'$, etc., on the athwartship plane. With the radii $1_{||}$ 1_x, we describe the arc, as above mentioned, passing through 1. With radii $2_{||}$ we describe the arc passing through 2. The center points are shown on $Y Y'$ at 2, 3, 4, etc. After these arcs are described, we proceed to describe circular arcs with radii 0 1. 0 2, 0 3, etc., passing through the points 1, 2, 3, etc.

Set off from O the distance $P \div 2\pi$ and draw from the point Z straight lines to the points 1, 2, 3, etc. With $Z1$, $Z2$, $Z3$, etc., as radii and O as center, describe the small arcs $1'$, $2'$, $3'$, etc.

be left until the different views are finished.

Taking the fore-and-aft view, we proceed as follows: With the dividers take the distance $1B$, and set this distance off on either side of the line 1_x 1_o, using the point 1_o as center, as shown with O' and O'''. With the length $2B'$ set off on either side of the line 2_x 2_o this distance and do the same for each point. Passing a fair curve through these points gives us the view when looking at the blade from the tip.

After these points are located, project up to the horizontal line, passing through $7i$. Thus the point O' is projected up to the line, passing through 1, and we obtain one point on the right of 1 as at O''. Projecting point O''' up to 1, we obtain point O^{IV}. Proceeding in this way for the different points, we obtain a series of points, and by passing a curve through these we get the contour of the blade in the fore-and-aft plane.

Having computed the thickness of the blade at the root and tip, set these distances off and draw a line through them, connecting the blade to the hub with fillets. It is now possible on

the thwartship plane to show the shape of the blade. This needs no explanation, as it is self-evident.

Assume that we have given the projected dimensions. With a distance $P \div 2\pi$ set off from O, erect the pitch lines from Z to 1, 2, 3, 4, etc. With a radius equal to $O1$, $O2$, $O3$, etc., and with O as center, describe the circular arcs passing through 1, 2, 3, etc. With a radius $Z1$, $Z2$, $Z3$, etc., and O as a center, describe the circular arcs 1′, 2′, 3′, etc. Where the circular arcs pass through the point on the projected area, draw a diagonal line to O, intersecting the arc 1′. From this point of intersection of the diagonal with the arc 1′, drop a perpendicular. From the point of intersection, as at A, on arc 1, draw a horizontal line $A\ B$, parallel with $X\ X'$, and where the horizontal line intersects the perpendicular, this point of intersection is a point of the developed contour of blade. Proceeding thus, we obtain a series of points, and by passing a fair curve through same, we obtain the developed contour. The fore-and-aft view is as described above. It is as well to show the outline of the palm of the blade, showing the location of the holes for studs, the elongations, etc.

While the method of elliptic arcs is the most workmanlike, yet the three methods give precisely the same results. The two methods described above are simpler and much easier to handle. The writer has used these methods for several years, and while, in a majority of cases, he has used the elliptic arcs, it was due to the pattern maker measuring and building his pattern as described. The proof of the correctness of the above construction is very tedious, and space will not permit of the mathematical demonstration here. If we lay down the elliptic arc we will see that the difference is so slight that it is only by mathematical proof that we are able to discern any difference. Before closing this article, the writer would like to try and impress, not only on draftsmen, but on designers in general, the necessity of very accurate data in reference to this most important part of marine engineering. In the use of this method full-sized drawings of the developed areas were made, and when the pattern was made these were tried over the blade. The shape was laid out by the three methods described and made to shrinkage rule. There was exact coincidence.

SPEED TRIALS OF THE DESTROYER COSSACK*

BY SIR PHILIP WATTS, K. C. B., F. R. S., LL. D.

In the discussion which followed the reading of Mr. J. E. Thornycroft's paper last year I stated that the Admiralty were taking steps to obtain by a series of comparative trials additional data concerning the effect of shallow water upon the speeds of ships.

The trials have been carried out, so far as the exigencies of the service have permitted, and, although they are far from being as full as could be desired, they will probably be regarded as of sufficient interest to be placed on record in the Transactions of this institution.

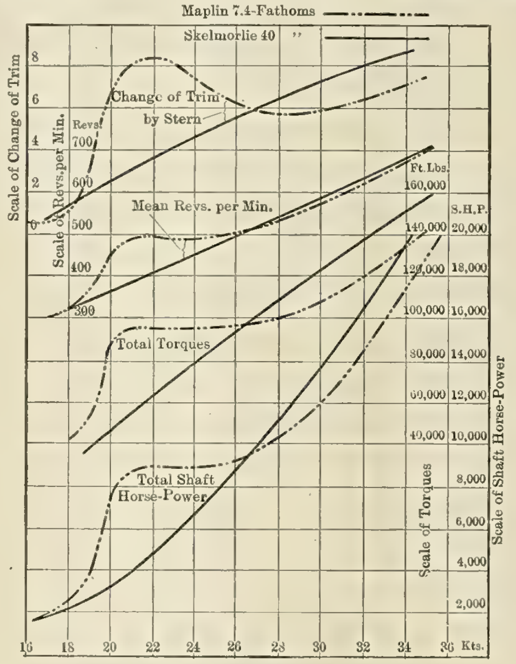
A full series of measured-mile runs was made with the *Cossack* at speeds varying from 17 knots to 34.5 knots, first on the Maplin Sands, and afterwards at Skelmorlie (depth, 7.4 fathoms at the Maplins, and 40 fathoms at Skelmorlie). They were made under as fair conditions as can ordinarily be secured without undue expenditure of time and money in waiting for specially favorable weather. The conditions were practically the same as on the official trials of this type of ship, except that there were no restrictions as to the consumption of fuel. The Cossack was chosen for the purpose as she had recently been delivered, and her propeller shafts had been calibrated for torsion stresses.

* From a paper read before the Institution of Naval Architects, April, 1909.

Each shaft had Bevis-Gibson flashlight torsionmeters of the axial type, supplied and erected in place by Messrs. Cammell Laird. It was found possible to get a length of shaft of 20 feet between the two discs of the apparatus, so that the readings on the scale at the eye piece were fairly open and reliable; and as the torsionmeters, when once fitted, were not disturbed till the experiments were completed, any slight fluctuation of torque with revolution does not vitiate the comparison of the results obtained on the different trials.

Revolution counters, worked from each shaft, were fitted on the upper deck, and a 20-foot water level was erected in the middle line plane of the ship, to enable the change of trim to be accurately measured. The vessel was kept nearly at the same trim and displacement throughout the trials.

The speeds over the mile were carefully taken by independent observers. The wave profiles were obtained by measuring down from the gunwale at various positions along the



DATA FROM SPEED TRIALS OF THE COSSACK.

ship. In the case of the stern wave the height and distance of the crest astern were accurately measured, and the profile in other respects was sketched by an observer.

The depth of the water in which the runs were made on the Maplins was taken at fairly regular intervals throughout the trials, the course having been previously carefully sounded from end to end, and found to be very uniform in depth.

The data obtained, after correction for any slight variation in displacement, etc., are shown in the figure annexed. It will be seen that the general characteristics of the curves closely correspond to those obtained by Messrs. Yarrow, Herr Popper, Major Rota, Captain Rasmussen, and Messrs. Denny. With her maximum power the *Cossack* is able to develop in shallow water a speed of about 1.4 knots in excess of that which she would develop in deep water at the same displacement and with the same shaft horsepower.

It is probable that the water at Skelmorlie is sufficiently deep to eliminate the effect of the bottom in these experiments. The results given by Major Rota show that a depth of 34 fathoms should be sufficient for this vessel's purpose. This is also confirmed by the experiments with a German torpedo boat in 1904, which showed that at a depth of 40 meters the resistance differed but slightly from that at 60 meters.

The results obtained for the *Cossack* may be used for other vessels of approximately the same size and form, but they do not apply directly to vessels differing materially in size and form.

SOME EXPERIMENTS WITH LIGHTENED BEAM BRACKETS.—II.

BY R. EARLE ANDERSON.

The problem now presented is to embody the results set forth in the previous table in a practical working formula capable of being used in determining the scantlings in any given case. It is evident that any such formula must be wholly empirical, and for this reason, and also for facility in using, it is desirable that the formula be as simple as possible. As the action of the main portion of the bracket is considered to be essentially a strut action, it seems proper to base the formula on some existing column formula in full realization of the facts, however, that the bracket is not a simple strut, and that the constants employed in the various column formulae in common use are based upon tests of a nature wholly different from the nature of the tests undertaken in the present investigation.

After careful scrutiny of the field, the formula most suited to serve as a basis upon which to work appears to be Johnson's parabolic formula, which takes the following form:

$$p = S - c\left(\frac{l}{r}\right)^2 \qquad (1)$$

Where

- p is the ultimate unit stress in pounds per square inch,
- S is the elastic limit of the material in pounds per square inch,
- l is the length of the column in inches,
- r is the radius of gyration in inches,
- c is a constant.

This formula has the great advantage of simplicity, and involves only one empirical constant. Both of these virtues make it particularly adapted to such use as that to which we propose to put it.

Means for determining the actual elastic limit of the material from which the bracket specimens were made were unfortunately not available. The value of S had therefore to be assumed, and as the nature of the sheet metal and its process of manufacture made it very probable that the elastic limit would be high, the value of S was taken at 40,000 pounds per square inch.

Using this value and taking successively the four average values of p obtained from the four types of brackets, the corresponding values of c are as follows:

Bracket No. 7, $c = 12.45$
" " 8, $c = 13.85$
" " 11, $c = 9.1$
" " 12, $c = 12.45$

These values, except in the case of No. 11, are very close together. The average value is 12. Embodying this value of c in the formula we have

$$p = 40{,}000 - 12\left(\frac{l}{r}\right)^2 \qquad (2)$$

As was expected, this constant is much greater than those used in Johnson's formula for ordinary columns, the difference being due to the eccentric form of the strut portion of the bracket, and to the eccentricity of the load.

We now pass to the application of this formula to the actual bracket used on the ship. This bracket is shown in Fig. 3 (page 223). The most remarkable way of attacking the problem is to make the bracket capable of sustaining a bending moment equal to, or somewhat greater than, the bending moment which the deck beam or the frame bar is capable of withstanding. In the case of the vessels on which the beam bracket shown in Fig. 3 was used, the deck beam and the frame bar are of the same scantling and their section modulus is 0.724. Assuming that the ultimate strength of the material may be 65,000 pounds per square inch, the greatest possible bending moment which can be withstood by the bar alone is $65{,}000 \times 0.724 = 47{,}000$ inch-pounds.

It is sometimes the practice to consider a portion of the plating to which the beam is attached as acting with the beam, the breadth of plating so taken being generally three times the breadth of the flange of the beam. On this basis, and allowing for a rivet hole, the section modulus is 0.96, with a corresponding ultimate bending moment of $65{,}000 \times 0.96 = 62{,}400$ inch-pounds. In the actual case before us, however, the thickness of the sheer strake and deck stringer plating is very disproportionate to the size of the beam and frame bar, and the connections of plates to bars are by small rivets widely spaced, and hence probably insufficient to make plate and bar act together under any bending moment approaching the ultimate strength of the bar. Moreover, the sheer strake is connected through washer liners which certainly make any such combined action of plate and beam quite impossible. It seems proper, therefore, to take the value derived from the simple beam, namely, 47,000 inch-pounds, as the bending moment to be transmitted by the bracket.

The next step is to calculate the load which would be produced in the two outermost rivets in the bracket by this bending moment. The rivets connecting the deck stringer angle to the plating unquestionably form a part of the bracket connection, and these are taken into account for the extent of one frame space. The area of each rivet is then multiplied by its distance from an assumed axis, and also by the square of its distance, the position of the neutral axis is found by making the statical moment equal to zero, the position of the true axis is corrected for, and the actual moment of inertia of the system of rivets is found, all in the usual manner.

The neutral axis is found to lie 1.795 inches from the center of the rivet in the throat of the bracket, and the moment of inertia is found to be

$$I = 62.54$$

Applying the ordinary formula for uniformly varying stress, namely,

$$p = \frac{My}{I}$$

we have for the stress in the outermost rivet, the distance of which from the neutral axis is 11.205 inches:

$$p_1 = \frac{M \times 11.205}{62.54} = 0.179\ M$$

and for the actual load in this rivet, the area of which, when driven, is 0.2485 square inch:

$$P_1 = 0.179\ M \times 0.2485 = 0.045\ M$$

Similarly for the next to the outermost rivet we have

$$p'_1 = \frac{M \times 7.995}{62.54} = 0.1278\ M$$

and

$$P'_1 = 0.1278\ M \times 0.2485 = 0.0375\ M$$

The total direct load passing through the outer or flanged portion of the bracket is thus

$$P_1 + P'_1 = (0.045 + 0.0375)\ M = 0.0825\ M$$

whence, by substituting the value of M, previously determined, we have for the bracket strut load 3,880 pounds.

The sectional area through the flanged portion of the bracket at midlength is 0.66 square inch. Hence the unit stress, due to the direct load, is

$$\frac{3{,}880}{0.66} = 5{,}880 \text{ pounds per square inch.}$$

To this must be added the stress, due to the bending moment produced by the eccentric loading. The amount of the eccentricity is equal to the distance from the neutral axis of the

strut section to the heel of the flange, minus the half thickness of the plate, since the load is applied on one side of the plate at one end, and on the opposite side of the plate at the other end. For an 8-pound bracket, the neutral axis is found to be 0.393 inch from the heel, and subtracting the half thickness of the plate, or 0.1 inch, we have for the eccentricity 0.293 inch.

The bending moment, due to the eccentric load of 3,880 pounds is therefore

$$3{,}880 \times 0.293 = 1{,}140$$

inch-pounds. The moment of inertia of the cross-section is found on calculation to be 0.1282 square inch inch square, and as the distance from the neutral axis of the cross-section to the most strained fiber in compression is found in the same calculation to be 0.393 inch, the stress due to the eccentric load is

$$\frac{1{,}140 \times 0.393}{0.1282} = 3{,}480$$

pounds per square inch. Adding the stress due to the direct load to that due to the eccentricity, we have for the total stress in the most strained fiber

$$5{,}880 + 3{,}480 = 9{,}300$$

pounds per square inch.

The next step is to determine whether the bracket is capable of withstanding this stress, and for this we use the formula (2). It appears wise, however, to adopt for actual use a lower value of the elastic limit than was used in interpreting the results of the experiments. The reasons for using the high value of 40,000 pounds for the thin sheet steel experimented upon have been stated. For the ordinary medium steel of which the actual bracket is made, we will use the value of 35,000 pounds as more nearly representing the material to be dealt with. This puts our formula in the following form:

$$p = 35{,}000 - 12\left(\frac{l}{r}\right)^2 \ldots\ldots\ldots\ldots\ldots (3)$$

The radius of gyration of the cross-section, found at the same time as was the position of the neutral axis and the value of the moment of inertia, is 0.441 inch, and as the length of the flange is 20 inches, we have

$$p = 35{,}000 - 12\left(\frac{20}{0.441}\right)^2$$

$$p = 10{,}700$$

pounds per square inch. Comparing this value, which represents the ultimate unit strength of the bracket, with the value previously found as the unit stress to which the bracket may be subjected by a bending moment in the beam sufficient to break the beam, namely, 9,300 pounds per square inch, we see that this bracket has a reasonable, but not too great, margin in its favor, it being highly desirable, of course, that in a case like this, where the fixity of the ends of the beams depends upon the efficiency of their connection, the strength of the connection should be greater than that of the parts connected.

Of course, the strength of the rivets requires also to be looked into. The information for this has already been obtained. In determining the load to be supported by the strut portion of the bracket, the stress in the outermost rivet was found to be

$$p_r = 0.179\ M$$

Putting in the value previously found for the ultimate bending moment of the beam we have

$$p_r = 0.179 \times 47{,}000$$

$$p_r = 8{,}400$$

pounds per square inch, which is, of course, way within the strength of the rivet.

The original design of the torpedo vessels upon which these brackets were used provided for 10-pound plate, but as a result of these experiments this was reduced to 8 pounds, whereby a considerable saving in weight was effected.

Further calculations on brackets of smaller dimensions, but with the same number and size of rivets and of the same thickness of plating, showed that the smaller the bracket the greater would be its strength, due to the shortening of the strut and the fact that the strength of the shortened strut increased more rapidly than did the load transmitted to it by the shortened rivet connection, the limit being reached, of course, when the stress produced in the outermost rivet is equal to the ultimate shearing strength of the material. The large size of the bracket was retained in the design because of the support given by it to the sheer strake and the main deck stringer, quite aside from its ability to resist racking strains. It is important to note, however, as a general principle, applicable to beam brackets, bulkhead stiffener brackets, and other similar structural members, that where the object is simply to resist a given bending moment the smallest bracket that will admit of efficient riveting will, if its edge be properly supported by a flange or by running part of the beam or stiffener out on it, be the strongest.

It may also be noted that where a stiffener of channel bar or I-beam section is split and carried down the edge of the bracket, or where a reverse bar is thus fitted, the stiffening should extend to the toe of the bracket, and it is very desirable where it does not cause too great complication to run the stiffening past the bracket clips.

In regard to the accuracy of the formulas (2) and (3), it should be stated that they are proposed with a considerable degree of reservation, for while the usefulness of the experiments upon which they are based exceeded the writer's expectations, the total number of tests was, of course, not great, and the uncertainty of the elastic limit of the material used introduces an unfortunate element of doubt. Care has been taken, however, to make all necessary assumptions on the safe side, and it is believed that until more elaborate experiments can be made on full-size brackets the formula (3), if used with proper discrimination, will give reasonable and safe results.

Summer Meeting of Naval Architects' Society.

The summer meeting of the American Society of Naval Architects and Marine Engineers was held at Detroit, Mich., June 24 to 26. The program was as follows:

FRIDAY, JUNE 25, 1909.

1. "Some Model Experiments on Suction of Vessels," by Naval Constructor D. W. Taylor, U. S. N., Vice-President.
2. "A Method of Determining Pressure for Steam Turbines," by Professor C. H. Peabody, Member of Council.
3. "The Resistance of Some Full Types of Vessels," by Professor H. C. Sadler, Member of Council.
4. "The U. S. S. *Michigan* renamed the *Wolverine*," by Commander W. P. White, U. S. N., Associate Member.

SATURDAY, JUNE 26, 1909.

5. "Shallow-Draft Steamers," by Charles Ward, Member.
6. "Material Handling Arrangement for Vessels on the Great Lakes," by Alexander E. Brown, Member.
7. "The Strength of Knees and Brackets on Beams and Stiffeners," by H. R. Hunt, Junior Member.
8. "Towing Problems," by T. S. Kemble.

MAST AND DERRICK MOUNTINGS.

25-TON STEEL DERRICKS.

Fig. 1 shows a 25-ton steel derrick fitted on deck. The derrick is 50 feet long, 22 inches diameter at the center, 18 inches at the ends, and the plating is 7/20 inch thick, with T-bar stiffeners 5 inches by 3 inches by ⅜ inch, with 10/20-inch diaphragm plates. A 10/20-inch doubling plate is fitted in way of the band for a length of 4 feet 3 inches. The band is placed 3 feet from the derrick head. and the doubling is arranged 1 foot 3 inches above the band and 3 feet below it.

The band is 9 inches broad by 1½ inches thick. On top of the band is arranged a snug, 2¼ inches thick, to take the attachment of the topping lift treble block. On the sides of the band 1½-inch wrought eyes are worked with a 1⅜-inch link, the link being made long enough to take the shackle of double guys; on the underside of the band a 2-inch wrought eye is worked to take a 2½-inch link. The link is to take the shackle of the treble purchase block.

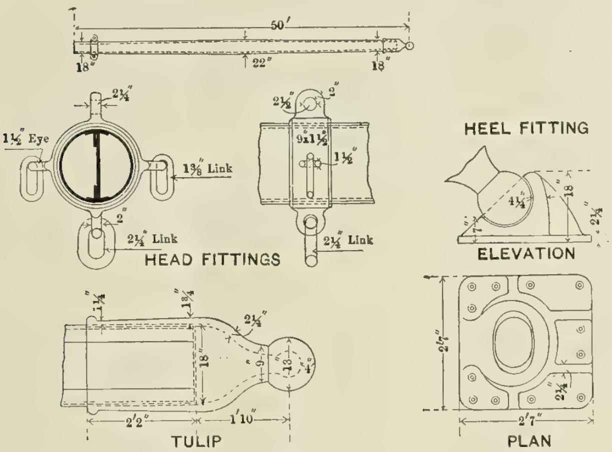


FIG. 1.

The heel socket is the well-known "cup type" of casting. The sole is 2 feet 7 inches broad by 2¼ inches thick, with holes for twelve 1¼-inch bolts. The extreme height is 18 inches. Four brackets are arranged for; one on each side and two on the right-hand side. Each bracket is 2¼ inches thick.

From the center of the ball to the end of the tulip is 4 feet. The diameter of the ball is 13 inches, and it is 4 inches thick after machining. From the center of the ball to the end of the derrick is 1 foot 10 inches. The thickness of casting varies from 4 inches at the ball to 2¼ inches at the end of the derrick. From the end of the derrick to the end of the tulip is 2 feet 2 inches, and the diameter of the derrick for that distance is 18 inches. The thickness of metal in the tulips varies from 1¾ inches at the end of the derrick to 1¼ inches at the end of the tulip. The tulip is 9 inches diameter at the ball. The ends of the derrick are closed with 6/20-inch plates tapped on.

25-TON WOODEN DERRICKS.

Fig. 2 shows a 25-ton derrick 40 feet long, 21 inches diameter at the center and 16½ inches diameter at the ends. This derrick is fitted on a mast, and on the mast are two brackets, 4½ inches deep by 7½ inches broad, with soles 5 inches deep and 1½ inches thick, of sufficient length to take eight rivets on each side of the mast. A distance piece, with jaws, is fitted between the brackets, to take the shod of the derrick. A pin, 3¼ inches diameter, is let down through the brackets and sleeved jaw; 2⅛ inches clear metal is left round the brackets and sleeved jaw. The jaws are 2 inches thick. From the center of the bracket pin to the center of the derrick pin is 9 inches. The snug taking the derrick pin is 7 inches deep by 3¼ inches broad. The length of heel shod from center of derrick pin is 3 feet 10½ inches. The forks of the shod are 4½ inches broad by 1⅛ inches thick, tapering to 3 inches broad by ¾ inch thick. At the heel of the derrick the shod is 1⅜ inches thick. Four 1-inch clinched bolts are fitted. Two bands are fitted 1 foot 10 inches apart, and are 6 inches broad by ¾ inch thick, and 5½ inches broad by ¾ inch thick, respectively. Eyes are fitted on the underside of the bands when it is considered necessary.

The upper band is 1 foot from the head of the derrick, and it is 7 inches broad by 1¼ inches thick; on the upper side of the band a snug is fitted to take a 1¾-inch shackle. This snug is 2 inches thick, and the shackle pin which passes through is 2 inches diameter; the height of the snug is made to suit the shackle. A 1⅜-inch link, taking a 1¼-inch chain as a bridle, is fitted to the shackle; 1¼-inch eyes are fitted at the sides of the band to take a 1⅜-inch link for double guys. On the lower side of the band a 2-inch wrought eye with a 2½-inch hole is worked; through this eye is fitted a link 12 inches by 8 inches by 2¼ inches, to take the shackle of the

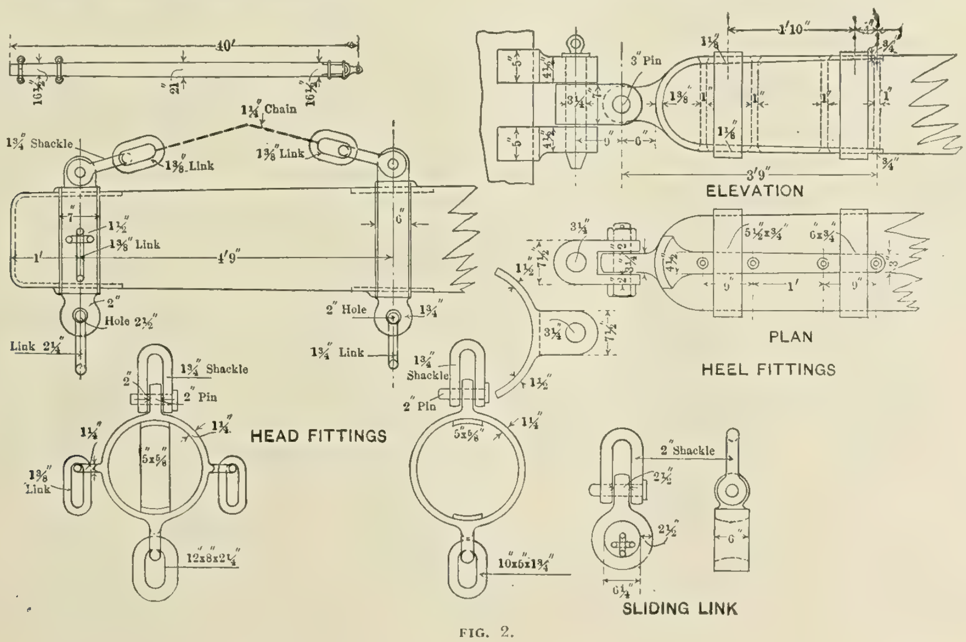


FIG. 2.

purchase block. At the head of the derrick a plate is fitted, 5 inches broad by ⅝ inch thick, with stops at the top and bottom of the band to prevent the band from moving when loads are applied.

The lower band is spaced from 4 feet 6 inches to 6 feet from the upper band; it is 6 inches broad by 1¼ inches thick, and the snug at the head is the same as for the upper band. No eyes are worked for guys. A 1¾-inch wrought eye is

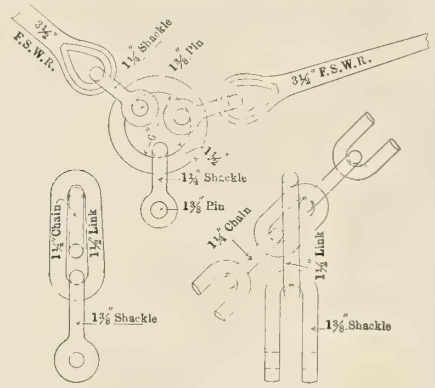


FIG. 3.

worked on the underside, with a 2-inch hole to take a link 10 inches by 5 inches by 1¾ inches, to which is attached the shackle of the purchase block.

The sliding link is 6 inches broad and 2 inches thick. A snug, 2½ inches thick, with height and breadth to suit a 2-inch shackle which is fitted to a sliding link, is also fitted. The 2-inch shackle may either take a 5-inch F. S. W. R. topping lift or a treble block, depending on the requirements of the shipowner.

Fig. 3 shows two types of cargo spans. The upper sketch shows the type usually fitted between masts. The span is 3½ inches F. S. W. R., with a ring 1½ inches thick, having

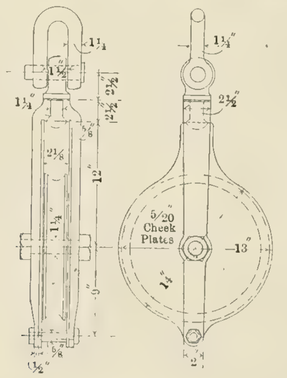


FIG. 4.

an internal diameter of 6 inches. The ring is connected to the span with 1¼-inch shackles. A 1¼-inch shackle is fitted to take a gyn block. This style takes loads of about 6 tons.

The lower sketch shows the method of fitting spans from mast to deck. The length of 1¼-inch chain may vary from a few feet up to 20 feet when the ends are secured to 4¼-inch F. S. W. stays. A long link is fitted, through which is passed a 1⅛-inch shackle, and from this shackle the gyn block is hung. A safe working load on this span would be 10 tons. When it is desired to move the gyn block over any part of the hatch, long links are fitted to eye plates on deck, and the span is shackled to the most convenient one.

The sheave of the lead block is 13 inches diameter and 2 inches thick. The sheave pin is 1¼ inches diameter, grooved for oil and fitted with a feather at the head to prevent the bolt turning. From the center of the sheave to the underside of the crown is 12 inches, and from the center of the sheave to the center of the distance piece is 9 inches. The crown is 2½ inches deep. From the crown to the center of the shackle pin is 2½ inches. The swivel head is 1½ inches thick, with a breadth and height to suit a 1¼-inch shackle; the swivel is 1¼ inches diameter. The jaws of the block at the crown are 2½ inches broad by ⅝ inch thick, and at the distance piece 2 inches diameter by ½ inch thick. The check plates are 5/20-inch thick, and the over-all width of the block is 14 inches.

PROPELLER COMPUTATIONS.

BY CHARLES S. LINCH.

In the issue of International Marine Engineering for February, 1905, there appeared in the editorial on propellers the following:

"The propeller of the present day is very largely an evolution. This evolution has proceeded, not along strictly scientific lines, but, if we may so state it, along the lines of least resistance. One designer has followed blindly in the footsteps of another, giving vent, perhaps, to a few of his own ideas in the matter, but being in the main fully as mindful of precedent and subservient to it as would cheer the heart of the most pettifogging lawyer to be found in a day's journey.

"The existence of such conditions would appear to indicate that there is no scientific basis for the design of the screw propeller, which conclusions are by no means in accordance with the truth."

The truth of the above remarks are self-evident to any one conversant with the methods of design carried on in some of our shipyards. There seems to be an abhorrence of scientific investigation, and an utter disregard for the compilation of data, preference being manifest for rule-of-thumb methods and so-called judgment. I do not mean to say this obtains in all cases, but so much of it has come under the observation of the writer that at times one wonders how it is possible that such conditions obtain. It is true that one or two of the principal works are considered too mathematical, but to those who care to design a wheel from formulæ derived from scientific investigation these works can be used. Durand's *Resistance and Propulsion of Ships* is so arranged that one needs but ordinary arithmetical knowledge to solve the problem of the proper proportions. Taylor's *Resistance of Ships* presents no difficulties, and the student or designer who cannot handle these works in their entirety should not be entrusted with the design of a propeller wheel, or, in fact, any marine machinery, as the days of rule-of-thumb methods are fast passing away.

It should be the aim of every designer to have at hand a series of curves or characteristics of blades—and in a short time one can accumulate quite a number which will cover a very wide range. The idea of considering the time spent in plotting these curves or making the necessary computations as wasted, or that they are too difficult for every-day use, is an utter fallacy.

In the issues of International Marine Engineering for December, 1907, and January, 1908, there was published a very complete description of the Hamburg-American steamer *Kronprinzessin Cecilie*. We will take this ship as an example, and not only show how closely both Durand's and Taylor's formulæ agree, but we will lay down the wheel and show the characteristic curves, and substitute the values and solve the equations.

DATA.

The designed indicated horsepower of each engine is 3,035; the designed revolutions per minute 79. The sea speed is taken at 14 knots.

From indicator cards in the writer's possession of a similar engine the friction was 10 percent. For a ship of these lines we would assign a wake factor of about 15 percent, a true slip of 25 percent, and the apparent slip will be 14 percent.

COMPUTATIONS BY DURAND'S METHOD.

The useful work is equal to (pitch $\times$ revolutions)^3 $\times$ (diameter)^2 $\times$ constants; or, if written as a formula, we have

$$U = (P \times R)^3 \times D'^2 \times i \times k \times l \times m.$$

The values of the constants are given in Durand's work. The writer enlarged the curves of area ratio and thrust ratio m from Durand's analysis and from Froude's investigations, and the values are more accurately determined.

PITCH.

$14 \times (1 - \text{wake factor}) = 14 \times (1 - 0.15) = 11.9$ knots.

$11.9 \times 101.3 = 1,205.47$ feet per minute.

$(1 - 0.25)\ P \times R = 1,205.47$,

or $0.75\ P \times R = 1,205.47$ feet

Therefore, $P \times R = 1,607.29$,

But $R = 79$ per minute.

Therefore, $P = 1,607.29 \div 79 = 20.345$ feet.

The pitch as built was 20.343 feet.

DEVELOPED AREA.

Taking the thrust ratio, or m, as 1.05 and passing over to where, by judgment, the curve of pitch ratio, 1.18, would intersect the horizontal, we find the area ratio would be 37 percent. That is, the area of developed surface would be 37 percent of disc area. The disc area would be 232.35 square feet; therefore, the area of developed surface would be 85.969 square feet. The area as given was 85.23 square feet, a difference of 0.739 square feet, or 0.134 square feet for each blade. The diameter as built being 17.0625 feet, the corresponding disc area is 230.465 square feet, and 37 percent of 230.465 square feet equals 85.27 square feet.

What is involved in this computation? A designer should have at hand wake factors for different ships and also blade factors, and when equipped with these he is in a position to handle these equations with a degree of confidence.

COMPUTATION BY TAYLOR'S METHOD.

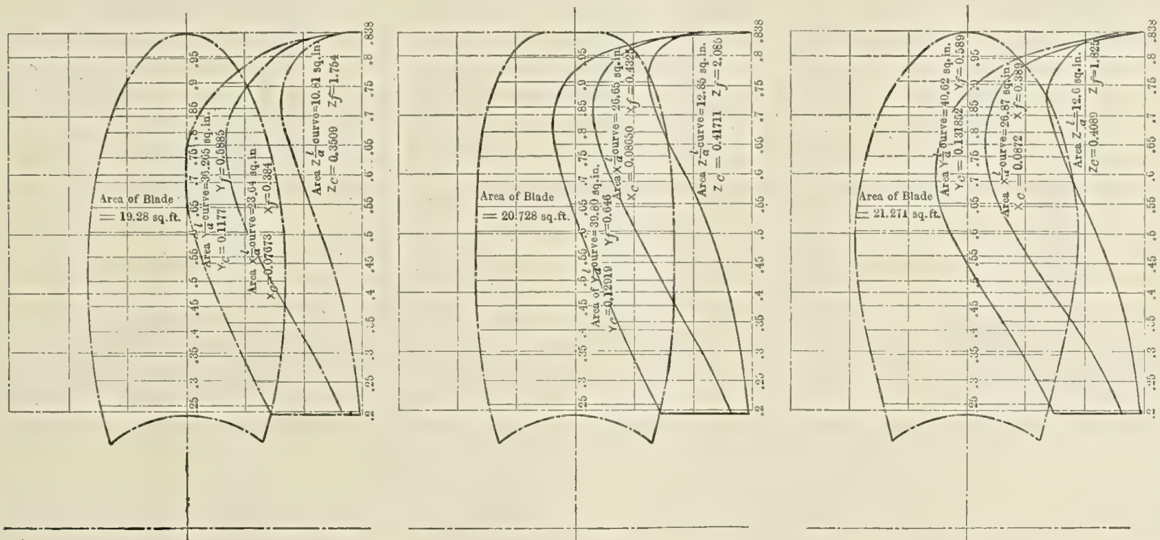
It is not out of place to say right here that Mr. Taylor's methods were rigorously deduced from the experiments of Froude, and are based upon his investigations. In the figure is shown the blade as built, and the three curves determining the characteristics X_t, Y_t and Z_t. Now, the brake-horsepower is equal to three times the number of blades in one wheel times the square of the diameter and constants, or

$$B.\ H.\ P. = 3\ Z \times \left(\frac{P \times R}{1,000}\right)^3 \times D^2 \times b\ (aS_t X_t + fZ_t).$$

Where Z = Number of blades, one wheel.
D = Diameter in feet.
P = Pitch in feet.
R = Revolutions per minute.
b = Mean width ratio.
a = 8.4 — 1 $\times$ diameter ratio.
S_t = True slip.
X_t = Characteristic.
f = Coefficient friction = 0.045.
Z_t = Characteristic.

Let us take the diameter as built, namely, 17.0625 feet:

We found $P \times R = 1,607.29$.



STANDARD ELLIPTICAL BLADE
DIAM. 17.0625 FT. PITCH 20.343 FT.

Mean Width Ratio	= 0.171
X_f For this Ratio	= 0.448
Y_f " "	= 0.668
Z_f " " "	= 2.052

STANDARD BLADE
DIAM. 17.0625 FT. PITCH 20.343 FT.

Mean Width Ratio	= 0.184
X_f For this Ratio	= 0.470
Y_f " " "	= 0.702
Z_f " " "	= 2.267

BLADE AS BUILT
DIAM. 17.0625 FT. PITCH 20.343 FT.

Mean Width Ratio	= 0.189
X_f For this Ratio	= 0.461
Y_f " " "	= 0.698
Z_f " " "	= 2.164

COMPARISON OF DIFFERENT TYPE BLADES.

DIAMETER.

The log of $P \times R$, or $1,607.29 \div 100$ = log of $16.0729 = 1.206099$.

Log $(16.0729)^3 = 1.206099 \times 3 = 3.618297$.

Corresponding number = 4,151.6.

The value of $k = 0.193$.

The value of $l = 0.670$.

The value of $m = 1.05$.

The value of $i = 1.03$.

Assume an efficiency of 63 percent.

Therefore, useful work $= 3,035 \times 0.9 \times 0.65 = 1,720.845$ horsepower.

Now, substituting and solving for D, we have

$$D'^2 = \frac{1,720.845}{4,151.6 \times 1.03 \times 0.193 \times 0.67 \times 1.05} = 2.96$$

$$D^2 = 2.96 \times 100 = 296,\ D = \sqrt{296} = 17.2 \text{ feet.}$$

Therefore, diameter of wheel = 17.2 feet.

The value of i is the blade factor.

The diameter of wheel, as built, was 17.0625 feet, or a difference of 1.65 inches, or 0.8 percent.

$$\frac{P \times R}{1{,}000} = 1.60729.$$

Log 1.60729 = 0.206099.
Log $(1.60729)^3 = 0.618297$.
Corresponding number = 4.1516.
Diameter = 17.0625.
Log 17.0625 = 1.231979.
Log $(17.0625)^2 = 2.463958$.
Corresponding number = 291.1.

$$\text{Diameter ratio} = \frac{17.0625}{20.345} = 0.838.$$

The value of $a = 8.4 - 0.838 = 7.56$.
The value of $X_t = 0.461$.
The value of $Z_t = 2.164$.
Substituting the values in the above equation we have

$$B.\ H.\ P. = 3{,}035 \times 0.9 = 2{,}731.5.$$

Therefore, solving for mean width ratio we have

$$b = \frac{2{,}731.5}{3 \times 4 \times 4.15 \times 291.1 \times (7.56 \times 0.25 \times 0.461 + 0.045 \times 2.164)} = 0.19$$

But $b = \dfrac{\text{mean width}}{\text{diameter}}$, therefore mean width $= 0.19 \times 17.0625 = 3.24$ feet.

$$\text{Mean width} = \frac{\text{area of blade}}{\dfrac{\text{diam. wheel} - \text{diam. hub}}{2}}$$

Therefore, area of blade $= 3.24 \times 6.544 = 21.202$ square feet.

The developed area of four blades equals 21.202 multiplied by 4 or 84.808 square feet. The diameter of hub was made 3.9739 feet. The area of Fig. 1 by planimeter was 21.271 square feet. This would make the total area of the wheel equal 85.084 square feet. The difference is due probably to the difference between points taken for area by the builder and the writer. In looking over the two methods we find for Durand's method the diameter of wheel is less than 1 percent larger than built. The developed area is nearly 1 percent greater. The pitch is exactly as built. With Taylor's method we would use the diameter as built. The pitch would be exactly as built, and the developed area 0.1 percent less than built.

In plotting curves of every blade we soon have a series of curves, the value of which to the designer cannot be overestimated.

Sufficient has been said to show the value and the readiness of computations from these investigations, and in analyzing the performance of wheels the ease and readiness with which they can be handled commend themselves to the designers. The time spent in using them is far less expensive than replacing new wheels on a ship, though it is hard to convince some of this fact.

Results with Producer-Gas Motor Boat.

The producer gas motor boat *Marenging*, recently built for H. L. Aldrich, publisher of International Marine Engineering, and described on page 110 of our March issue, has now been in service nearly two months, and has traveled approximately 1,248 miles. Anthracite pea coal has been used on all these runs, and the results, exclusive of dock trials, show that the boat will average between 800 and 900 miles on a ton of anthracite pea coal.

BREAKDOWNS AT SEA.

Repairing a Broken Stern Gland at Sea.

A few years ago, while I was fourth engineer of the steamship *V*———, en route to San Francisco and the Hawaiian Islands, we encountered that well-known and treacherous weather which frequents the region of the Straits of Magellan during the months of June, July and August. As the wind and sea grew more and more violent the ship rolled and pitched excessively, the indicator in the engine room at times showing a list of as much as 35 degrees. Notwithstanding the severe weather, however, everything in the engine room was working satisfactorily, with the exception of the thrust and

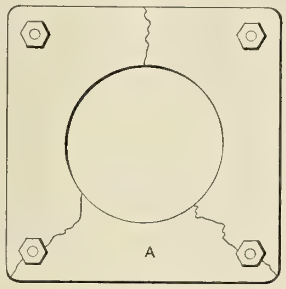


FIG. 1.

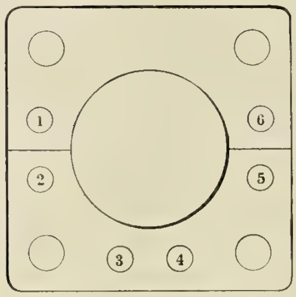


FIG. 2.

spring bearings, all of which carried a very high working heat.

Things continued in this way for the first two days, but on the third day, when the storm was at its height and everything on board the ship was getting a thorough sea test for its stability, one of the oilers, while paying his half-hourly visit up the trembling shaft alley, discovered that the port stern gland had been broken by the excessive springing of the tail shaft. The nature of the fracture is shown in Fig. 1, the piece *A* having dropped out and allowed some of the flax packing to work partly out at that point.

In order to effect repairs all hands were called and the port engine stopped, as there was a very dangerous shaft

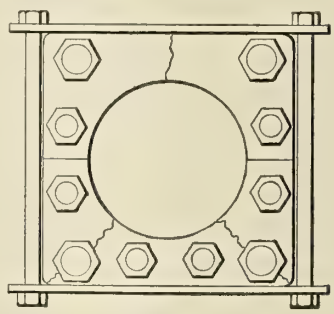


FIG. 3.

coupling revolving about 18 inches from the broken gland. After the engine was stopped it was found that there was no loose, heavy iron or steel with which to make suitable repairs strong enough to withstand the vibrating strains which had caused the fracture. Nevertheless, we had to do something, so the chief engineer gave orders to unhinge a small, heavy iron door about 2 feet by 5 feet by ½ inch thick, that led from the donkey boiler room to the 'tween decks. This was marked off the exact size of the gland, Fig. 2, and then it was cut in two, and a 2-inch hole drilled in each corner for the studs to pass through; also 1½-inch clearance holes were drilled at 1, 2, 3, 4, 5 and 6 to correspond with the repair studs that were being put into the broken pieces of the gland by two oilers.

After the door had been cut up, making two complete plates

with a total thickness of 1 inch, it was necessary to place a strip around the plates to clamp the four sides of the gland together; so, with the balance of the iron door two pieces were made 2 feet 8 inches long and 6 inches wide, with a 1½-inch hole drilled in each end. Then a slice bar was cut up, making two studs, 2 feet 6 inches long, which passed through the holes and clamped around the gland, as shown in Fig. 3. After bolting on the double thickness of plates and setting up the gland, the engine was started and the ship proceeded on its voyage.

This repair job held out remarkably well, considering the fact that the bad weather kept up for a week longer, and no further trouble was experienced with it during the remainder of the trip, which occupied about six months, four months of which was running time.

The Use of Wood for Breakdowns on Board Ship.

It is not suggested that wood should form the basis of a permanent repair, but that it forms a very useful medium where the ship does not carry a sufficient number of spare parts to enable the engine room staff to do more than patch up the job until the ship arrives at port.

It frequently happens that when the circulating pump bucket is packed with rope the chamber becomes so much scored that the working life of even the best rope that can be used for packing is only a few days. In order to get over this wear of

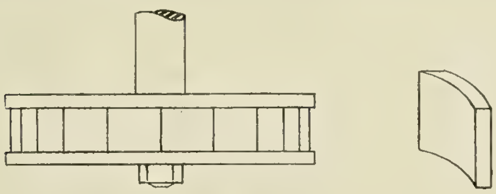


FIG. 1.

material, and the constant annoyance of stopping, due to these causes, a good plan is to pack the bucket with wood in the following manner: The staves of a barrel which has been used for packing pork or beef or oil may be taken and cut off to the required length in order to fit between the faces of the bucket, as shown in Fig. 1. They should then be fitted into the bucket, using a rough file or rasp to make them of suitable shape. The diameter should be slightly slack, in order to allow the wood to swell under the action of the water. It will be found that this will make a good, tight job, and also that the action of the wood will in almost every case be such as to smooth down the scores on the interior surface of the chamber, so as to enable rope to be used again in the pump.

A common mishap on board ship is the fracture of the rams on the feed or bilge pump, and should there not be a suitable spare part a wooden ram may be fitted, as shown in Fig. 2.

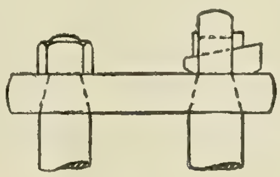


FIG. 2.

In such temporary repair work a boat's oar has been used for this purpose, making the wood a good fit in the cross-head. Soft packing should be used and the gland left slack until the wooden ram has expanded. This is a valuable method in case one feed pump ram is not able to adequately feed the boilers.

A rather daring method of repair with wood is in packing the steam piston. It sometimes happens that the piston itself fractures, as shown in Fig. 3, a certain amount of metal being left on the piston rod, the rest breaking away. As a temporary repair wood may be used, as shown in Fig. 4. Wood segments are made so as to fit into the metal remaining on the

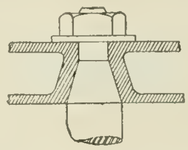


FIG. 3.

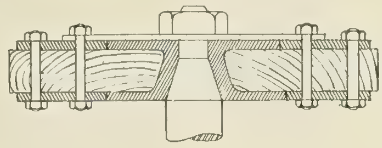


FIG. 4.

piston rod, and these are bound together with iron plates on either side, fitting up to the fracture and clamped by means of bolts, in order to further strengthen the part. The washer may be replaced by a piece of steel plate extending over the fractured part, having holes drilled in it to receive the bolts which clamp the plates on the upper and under side together. In order to preserve the strength of the wood it may be useful to make the packing up of two or three layers of wood, so arranged that the grain of one layer crosses that of the other; also a split-joint arrangement could be adopted. This not only insures steam tightness, but also gives greater mechanical strength in order to resist the bending action due to the steam pressure.

Repairing a Broken Circulator Piston.

In September, 1906, I was filling the position of third assistant engineer on the steamship *R*————, bound from New York to Galveston, Tex., and the first day out we encountered extremely rough weather, which at times caused us to slow the engine down owing to the excessive pitching and rolling of the vessel. Things went well at first, except that the thrust bearing carried a high heat, due to the sudden thrusts put upon it every time the ship would pitch and the engine give those well-known quick jumps before being throttled. On the fourth day, however, at 1.30 A. M., when the second assistant was on watch, a sudden succession of rapid cracks from behind the condenser suddenly brought the sleepy oiler to his senses, and, just as he ran around the engine, he saw the circulating engine's piston rod, crosshead brasses, etc., break loose from the connecting rod and

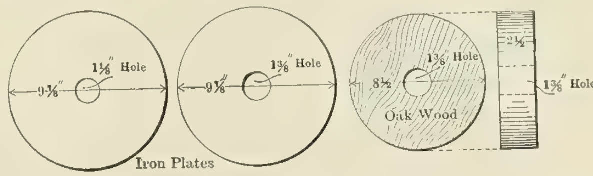


FIG. 1.

pound up and down a few times in the cylinder. With the circulator broken down and no pumps available to act in its stead, the engine had to be stopped until all hands could get below and rig up a jet condenser, the necessary connections being fortunately available for this purpose.

After the engine was again started, the cylinder head of the circulator was taken out, and it was found that the piston was completely smashed into small pieces beyond the hope of repair. The chief gave orders to make a temporary piston out of wood, the exact size of the cylinder bore, and reinforced with iron plates. This resulted in an argument between the chief and the first assistant, who claimed that a piston made in this way would swell in a short time and grip the cylinder walls and stick fast, whereas if it were made of a smaller diameter to allow for swelling it would permit too

much steam to leak by to operate the engine. The chief finally had one made the exact size of the cylinder bore, reinforced with circular plates cut from an ashpan damper, which were placed each side of the wooden piston and fastened with through bolts. After this was finished the engine was started up, but it ran only about five minutes when it stuck hard and fast, so that it was necessary to split it up to get it out.

We then proceeded to make another piston along more mechanical lines. We first cut two circular plates from another ashpan damper 1/8 inch smaller than the diameter of the cylinder bore, the top plate with a center hole 1 1/8 inches diameter and the bottom plate with a center hole 1 3/8 inches diameter to correspond with the taper on the piston rod.

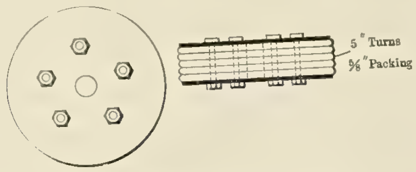


FIG. 2.—FINISHED PISTON.

Then a circular piece of oak wood, 2 1/2 inches thick, with a 1 3/8-inch hole through the center, was cut out, 1 1/2 inches less than the diameter of the bore. After the center holes in the two plates and the wooden disc were bored they were bolted tightly together, while five 1/2-inch holes were drilled through the piston to receive binding bolts. The piston was then bolted securely together and placed in the cylinder, and fitted on the piston rod. While placing in the cylinder, however, five turns of 5/8-inch rod packing were wound around the wooden part. This junk piston was tested by blocking the fly-wheel and admitting full steam pressure on top with the bottom drains open, allowing the steam to leak by the piston for a few minutes until it was fully expanded and became steam-tight. The engine was then started, and the piston gave satisfactory service for two months before a new cast iron one was made. F. J. W.

How to Run an Engine With a Broken High-Pressure Slide Rod.

A good many marine engineers do a lot of unnecessary work in order to get their engines into running order after the breaking of their high-pressure slide rod, an accident which is not at all uncommon at sea. They go to the extent of disconnecting the high-pressure connecting rod, slinging up that engine, blocking up the steam ports and various other miscellaneous jobs, before they get their boat under way again. It may therefore be of interest to briefly detail a method that was adopted in the breaking of a high-pressure slide rod in a two-cylinder compound engine. The spindle was broken in the valve at a bad weld, and all that was necessary to run the ship into port on the low-pressure engine was the following procedure:

The high-pressure slide valve was taken completely out, and the rod was examined in order to see if it was bent in the stuffingbox. As this was not the case it was left in its place, free to move up and down with the motion of the eccentric. Liners were placed under the feet of the low-pressure valve rod in order to obtain an additional amount of steam on the up-stroke, and the steam pressure was reduced in order to suit the engine working on the low-pressure cylinder only. After one or two attempts the low-pressure crank passed over its top center, and after this everything was plain sailing. As the high-pressure piston was in equilibrium, there being equal pressure on the top and bottom surfaces, there was no necessity at all to block up the steam ports, and there was also no necessity for disconnecting the connecting rod and slinging up the high-pressure engine. The extra steam consumed in pulling round this engine did not amount to very much, although, of course, the consumption of coal was slightly increased. A great point, however, was that the time taken in effecting the repair was considerably reduced over the ordinary method above described, and this is a very important factor where the vessel may be in a heavy sea.

The Fracture of a Tail Shaft.

On board a boat which was proceeding under water ballast, with a quantity of sand ballast in the afterhold, a fracture occurred in the tail shaft just inside the stern tube, as indicated in the sketch. The first step in order to make repairs was to remove the sand ballast from the afterhold onto the forward deck and also to pump out the water ballast in the after-hold. This set the ship down by the head, thus lifting the stern tube clear out of the water. At this stage of the proceedings it was found that the propeller and the afterpart of the shaft had dropped off, and were, of course, lost.

It was next attempted to draw the shaft through the liner into the boat, but it was found that this could not be done, and jacks had to be applied in order to push the crank shaft out again. A staging was therefore hung over the stern of the boat, and upon inspection it was found that the shaft had broken at a point about 3 inches inside the liner, and it had expanded this liner, thus preventing the shaft from being drawn through because of a cutting action. It was therefore necessary to cut off the expanded part; and after this was done the shaft was got into the boat. A wooden block was then made and put in the stern tube until the spare shaft was made ready. Fortunately the ship was well equipped for the job, and there was a spare shaft and propeller in reserve. Moreover, the after end of the tunnel was built to such a height that the broken shaft could be taken out and the new one put in without having to take the tunnel top off. Bars were fitted onto the tunnel and bolted onto the same, upon which the shaft rested, so that there was no necessity to use blocks of wood. At the same time the whole experience was a rather trying job, because, as the ship was in the Atlantic, it was constantly rolling, which rather impeded the progress of the work.

A Broken Slide-Spindle Block.

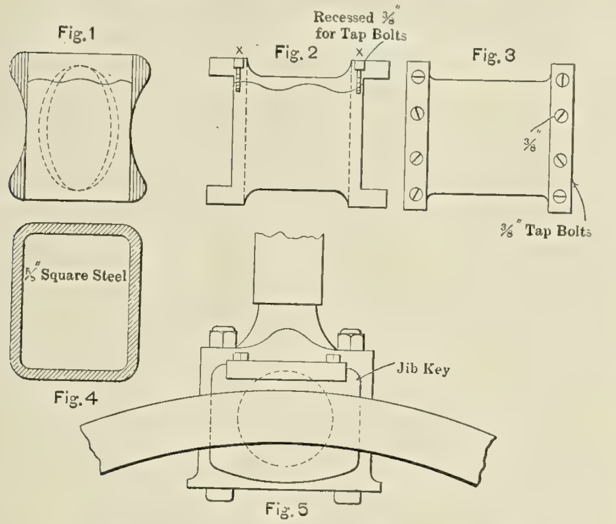
Fig. 5 shows the construction of a slide-spindle block which was fitted on a boat trading between Great Britain and America. In order to take up the wear and tear of the block on the top and bottom faces of the link, and to render it adjustable at all times, a fitting called the "gib key" is fixed to the block by means of two 1/2-inch tap bolts on each side. It is customary to reduce this adjustable fitting a sufficient amount to allow of several thin liners being placed on each side, in order to take up the great wear and tear occasioned by the constant working of the block on the go-ahead end of the link.

In the case under consideration this adjustment had been made a few days previous to the accident, and, unfortunately, it had been left too tight, so that when the boat was stopped for a pilot and the engines were ordered "full astern," the block suddenly snapped off at the top as shown in Figs. 1 and 2. This practically disabled the engine, and as the next step of the voyage was to proceed up the Mississippi, where a considerable amount of "backing and filling" would take place, it was considered more advisable to come to anchor and make an immediate sound repair of the fracture than go ahead with the partially disabled boat. Fortunately, a small country blacksmith's shop was found in the vicinity of the anchorage,

and he had a few pieces of square section steel bar of various sizes which would form raw material for the repair.

The first step was to chip off the rounded ends of the block, as shown in Fig. 1, in order that a good bedding surface could be obtained for the bands which were to be applied. Four holes were then drilled and tapped on each side of the block, well down into the lower half, as shown in Fig. 2. Each hole was ⅜-inch tapping size, and the holes were recessed sufficiently to allow the tap bolts to be let in flush with the top of the block. In order to bring these bolts squarely into place, slots were placed in their heads, and they were firmly and tightly screwed into position by means of a screwdriver fitted into a ratchet brace. The appearance of the repaired piece is shown in Fig. 3.

A steel band of ⅝-inch square section was then made of bar material, strongly welded, and this was firmly shrunk over the four sides of the block at the part previously occupied by the



rounded shaded portions in Fig. 1, one of these bands being placed at each end of the block. This effectually covered up the recessed heads of the tapped bolts and rendered them safe from working slack and coming out. The whole repair was a very neat and substantial job, and—from another vital standpoint—it was a very cheap one. The blacksmith's charge for his part of the work, including labor and material, was only $6, and the engine-room time occupied was only a few hours. In order to show that it was a perfectly sound repair it may be mentioned that the boat came through a very fierce Atlantic gale with it, and had it in use for nearly four months before it was possible to get it replaced by a new one.

It was decided by the inspecting engineer to keep this repaired block as a standby, and at the same time it was suggested that the three go-astern ends of the links should be softened and reduced in order to render the links capable of being changed end for end when necessity arose. It may be of value to suggest here that if the majority of engine builders were to adopt the construction already made by one or two well-known builders, and were to fit the pin in the center of the link where the drag arms are coupled, the tedious process of softening and reducing could be entirely obviated.

Broken Coupling Bolts on a Marine Shaft.

In the event of the bolts in a shaft coupling working slack and breaking away, if some form of replacement is not made the ship is virtually helpless, and it frequently occurs that there are no spare parts for such a purpose on board ship. This has been overcome in practice by taking out one bolt from each of the other shaft couplings and fitting these into the coupling which is disconnected by the broken bolts, and the repair has been strong enough to bring the ship home.

THE MARINE STEAM ENGINE INDICATOR.—I

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

Almost coincident with his invention of the steam engine, James Watt brought out the steam engine indicator. Hand in hand they have progressed towards that goal of all inventions—perfection. Improvements in the steam engine have been met with equal advancements in the design of the indicator to adapt it to such new conditions as have arisen. Volumes have been written on both subjects, and at the present time there is little that is new to be said on either. However, of the many treatises on the indicator, there is none which does not contain some feature not embodied in other books on the subject, and the object of the writer in the following chapters will be to bring out the best features of the standard literature on the subject, and in general to give a resumé of marine indicator practice as it exists to-day.

HISTORICAL.

The original Watt indicator consisted of a small steam cylinder, open to the atmosphere at one end and in communication with the engine clearance space at the other, through a suitable pipe and cock. Working in the cylinder with a nice

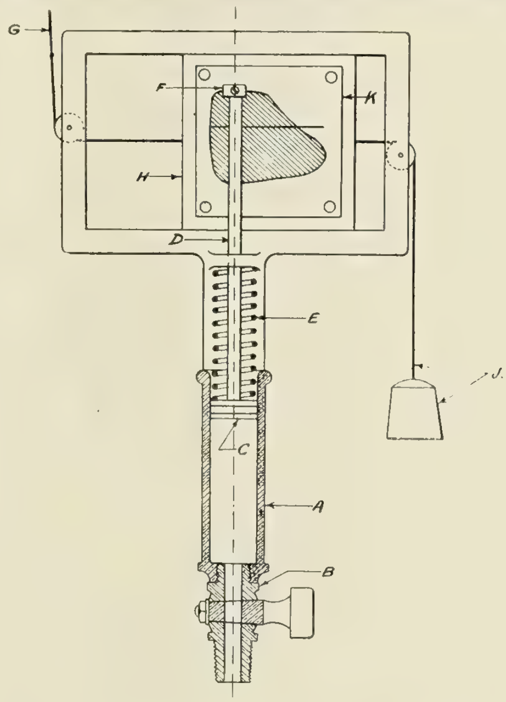


FIG. 1.

sliding fit was a small piston, its rod towards the outer end of the cylinder, the combination being constrained to move in a straight line by a guide near the outer end of the rod. The movement of the piston was regulated by a helical spring surrounding the rod, fixed to the frame of the instrument at one end and to the piston at the other. When the pressure in the cylinder was greater than that of the atmosphere the spring was compressed, and when the exterior pressure exceeded that within, the spring was extended. With the engine in operation the indicator piston was caused to reciprocate, the changing pressures being indicated by a pointer attached to the outer end of the piston rod sliding over a fixed scale. With the slow, rotative speeds of the early engines, it was possible to obtain an idea of the action of the steam in the main cylinder by watching the pointer, and Watt made great use of the instrument in this shape in perfecting his engine.

The first improvement on the original instrument was made by Watt himself, and consisted of the addition of a sliding

panel moved by the parallel motion of the main engine. The instrument as used about 1815 is shown in Fig. 1. *A* is the steam cylinder, *B* the stop cock, through which connection is made with the engine cylinder, *C* the piston, *D* the piston rod, *E* the spring, *F* the pencil holder, *G* the cord attached to the parallel motion of the engine for the purpose of pulling the panel *H* to the left, and *J* the cord and weight for hauling the panel to the right on the return stroke. With the instrument connected up and the engine in operation, the panel with the paper card (*K*) attached, had a reciprocating motion horizontally, which was a reduced copy of the motion of the engine piston, and its position at any instant was an index

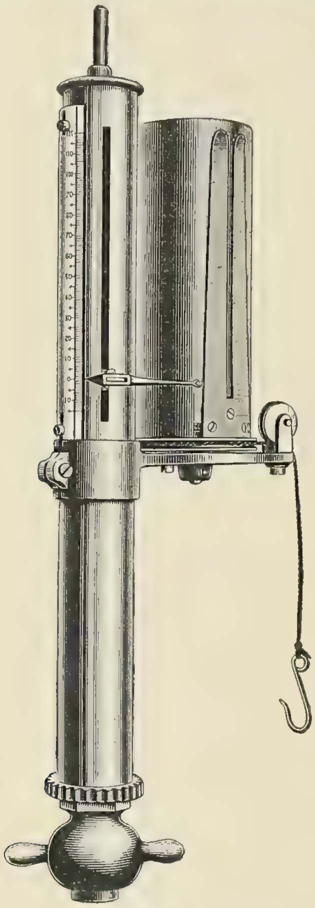


FIG. 2.

of the piston position at that time. The pencil, by its vertical height, indicated approximately the varying pressure in the engine cylinder at every instant. The combination of these two motions caused the pencil to draw a closed diagram on the card as shown in the figure. The inclosed area has been cross-hatched in order that it may be easily distinguished.

McNaught's indicator, which followed that of Watt, is shown in Fig. 2. This instrument was in general use until about 1862. It differed from the Watt instrument in that a drum, turning on a vertical spindle, was fitted in lieu of the sliding panel, and a spiral or helical spring inside the drum took the place of the counterweight. Various forms of this instrument were made in Great Britain and the United States. Fig. 2 was taken direct from an early American McNaught indicator, now in possession of the American Steam Gauge & Valve Manufacturing Company, of Boston, Mass.

Owing to the length of spring and the long piston stroke necessary to produce legible cards, this instrument was suitable only for the most moderate pressures and rotative speeds. When an attempt was made to use this apparatus with the higher speeds coming into use in the fifties, the long and tremulous spring was put into violent oscillations by the momentum of the moving parts, with the result that the cards were neither legible nor trustworthy. As an example of the best that could be done with the McNaught indicator at speeds of about 200 revolutions per minute and 130 pounds of steam, we quote from Mr. Charles T. Porter:*

"The two preceding diagrams (Figs. 3 and 4) . . . are fair average samples of a large number taken in February, 1856, by the late Daniel Kinear Clark, from the locomotive *Canute,* on the London & Southwestern Railway, with an indicator of the best construction then known, and which had been expressly prepared for the purpose. . . . The attempt to conjecture what the true form of these diagrams should be—to learn from them, for example, what proportion of the boiler pressure was obtained in the cylinder, and how much the pressure fell before reaching the point of cut-off at the speed of piston employed—points which it is of the highest consequence to ascertain—is clearly hopeless. It is to be observed, also, that the pencil does not, in either case, follow the same line during the successive revolutions of the engine, but describes quite different lines."

When such results as Figs. 3 and 4 were the best that could be obtained by a highly-skilled operator with a specially constructed instrument, it can easily be seen why the indicator was fast falling into disrepute as an instrument of precision,

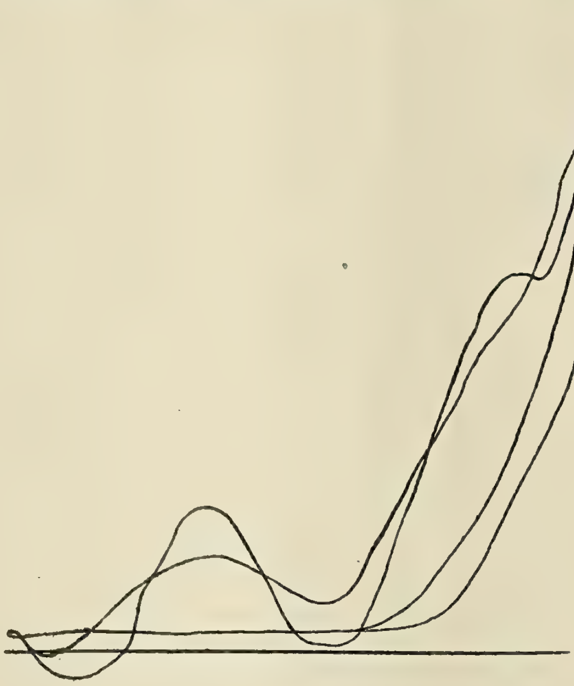


FIG. 3.

and had not an improvement been made about this time the indicator must have gone out of use, except for slow speeds and low pressures.

About 1862, as a result of efforts to improve the instrument, Mr. C. P. Richards, of Hartford, Conn., brought out the indicator bearing his name, which embodied nearly every essential feature found in modern types. The pencil was connected to the end of a lever of the third order, the piston being joined near the fulcrum. This arrangement reduced the travel of the indicator piston and the length, compression and extension of the spring. Thus the errors due to inertia and the long spring of the Watt and McNaught instruments were much reduced. The so-called multiplying parallel motion used on this instrument—by means of which the pencil was constrained to move in an approximately straight line—was an invention of Watt. He used this linkage to guide the crossheads of his engines in lieu of the now familiar cross-head

* "The Richards Steam Engine Indicator."

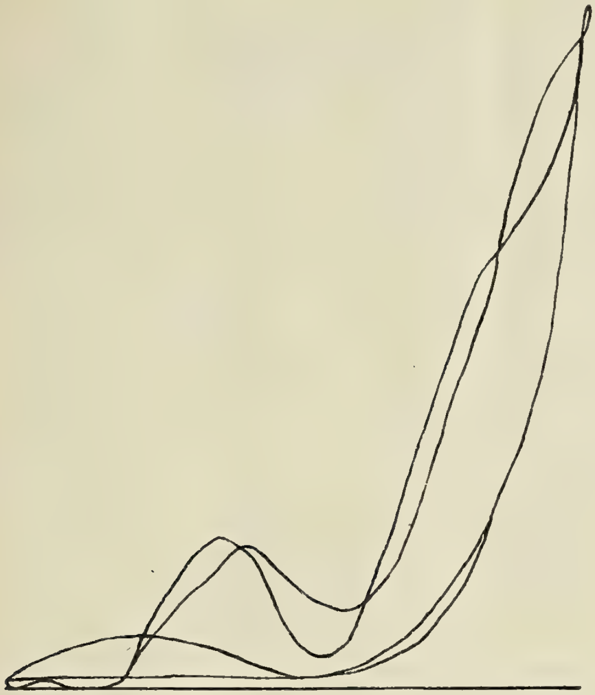


FIG. 4.

slides; but to Richards must be given the entire credit of applying it to the indicator. This motion will be discussed in detail hereafter. A drawing of the Richards indicator, copied from an old cut, is shown in Fig. 5.

The continual increase in speeds and pressures made desirable an instrument with a lighter pencil mechanism than that of Richards, and to meet this want Mr. J. W. Thompson brought out his instrument about 1875. Fig. 6 shows one of the first of this pattern made in the United States. The drawing was made directly from an indicator which had been in use at sea for upwards of twenty-five years. In the Thompson instrument, with its light pencil mechanism, we have the essentially modern design. The original layout has been changed but little, and at the present time it is still considered to be one of the best forms for general use.

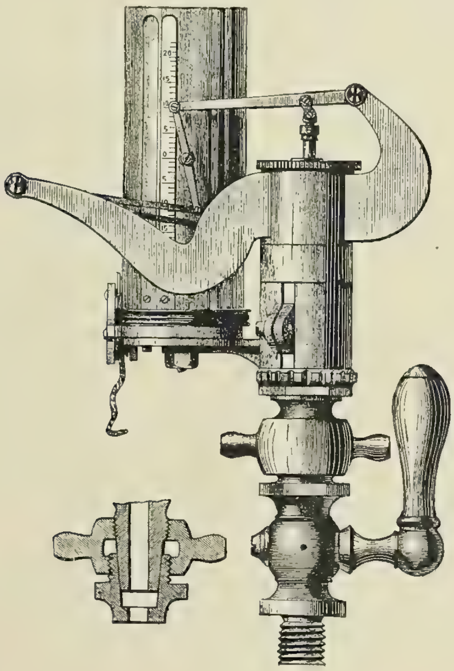


FIG. 5.

MODERN INSTRUMENTS.

The writer will endeavor to describe here some of the important details of the modern indicator, more especially those which differ most in the various instruments, leaving to the readers' good mechanical judgment the selection of a design which will best serve his purpose. For ordinary valve setting the most *extreme* accuracy may not always be necessary, just as it is unnecessary to use a micrometer for taking the data from which to compute the pitch of a screw propeller or to use the ship's chronometer when reading the engine counter for revolutions per minute. In most instances, however, it is best to use the greatest care in the selection and manipulation of the instrument, especially where high rotative speeds or other difficult conditions must be met. In taking data to be used in subsequent designs (to which use cards turned over to the engineer superintendent are liable to be put); or where premiums are paid or penalties exacted for horsepower on trials, or where changes are to be made involving the expenditure of money, the best instruments are not good enough. Generally speaking, the sea-going engineer is advised to obtain the best instruments possible, attach them to his engines correctly and manipulate them with the greatest precision.

In the perfect instrument, the pencil should show by its vertical height the pressure beneath the indicator piston at

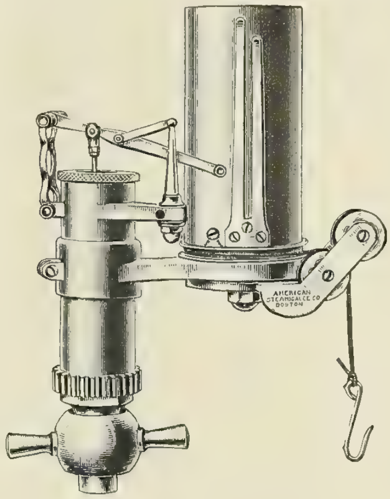


FIG. 6.

any instant, and by its horizontal position on the diagram the position of the engine piston at the corresponding time. Simple as these conditions are it is impossible to fulfill them, owing to the fact that the various parts of the instrument must necessarily have weight, and therefore inertia. Inertia may be defined as that property of matter by which it tends, when at rest, to remain so, and when in motion to continue in motion in a straight line, unless acted upon by some external force. Generally speaking, the effects of inertia increase with the weight or mass of a body and the speed with which it moves. It is therefore evident that the best instrument is the one in which the least weight is moved through the least distance in the production of diagrams of equal area.

STEAM CYLINDERS.

The steam cylinders in most indicators are fitted with liners very similar in principle to those used in the cylinders of marine engines. They are usually made of a bronze alloy suited to the varying temperature to which the indicator is exposed.*

The general idea is expressed in Fig. 7. The liner is centered and secured at *A*, and as it is out of contact at all other parts it is free to expand and contract longitudinally. With

* As ammonia attacks all of the bronzes, indicators are entirely steel fitted when used on ammonia compressors.

this arrangement no lateral distortion occurs with change of length; worn liners are easily renewed by the insertion of duplicates, and the cylinder area is easily reduced—when desired—by fitting liners of smaller bore. The annular space *B* fills with steam of the same pressure and temperature as that beneath the indicator piston and acts as a sort of steam jacket.

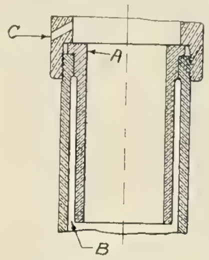


FIG. 7.

The outlet *C* prevents back pressure or the formation of a partial vacuum above the piston.

The bore areas of these liners vary from 1 square inch—in some of the newer steam-engine instruments—to 1/32 inch, or even smaller, in those used for heavy ordnance and hydraulic work. The areas usually decrease in a regular geometric series with a ratio of ½, thus 1, ½, ¼. * * *

PISTONS.

In the design of indicator pistons, the principal points aimed at are lightness, reasonable steam tightness and freedom of movement. They are made as light as possible consistent with strength, and the various makers have found by

Fig. 8

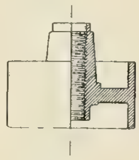


Fig. 11.

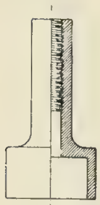


Fig. 9.

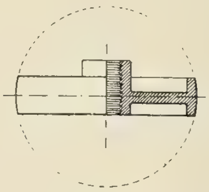


Fig. 12.

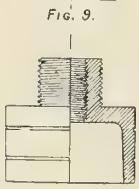


Fig. 10

TYPES OF PISTONS.

experience the limit to which they can go in this direction. Steam tightness is sought in most cases by making the pistons quite deep, and in some instances by turning grooves in the working surfaces for water packing. Only approximate tightness is necessary, however, as the supply pipe is large, and unless the leakage of the piston is so great that a back pressure is created on the atmospheric side it will affect the instrument but little. Lack of freedom of movement is usually caused by the piston becoming "cock-billed" in the cylinder. This may be caused by the spring buckling or the piston rod being out of line, and is usually guarded against by connecting the piston rod—and sometimes the spring also—to the piston by means of some form of universal joint.

A few of the various types of pistons are shown in Figs. 8 to 12. Fig. 8 is a form used in ordance and hydraulic work where heavy pressures are met with, and has a comparatively small area. Fig. 9 is a ¼-inch area piston, used for gas-engine work in a steam-engine indicator with a bushed or reduced cylinder. Figs. 10 and 11 are common forms of ½-inch area pistons used for steam-engine work only. Fig. 12 is a 1-inch area piston, whose working surface is an equatorial zone of a sphere. With this form the piston cannot jam, even when canted. Pistons are made of both bronze and steel. Diaphragms similar to those used in reducing valves have been used in lieu of pistons, and in one form of instrument the steam gage spring tube is used.

PISTON SPRINGS.

In order to obtain a correct diagram, the motion of the piston must be exactly proportional to the pressure beneath the indicator piston, and if the spring is not correct the entire instrument is useless. so far as a correct measurement of

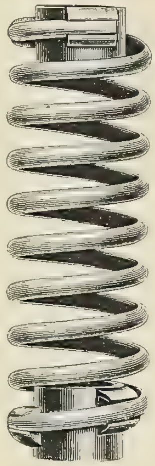


FIG. 13.

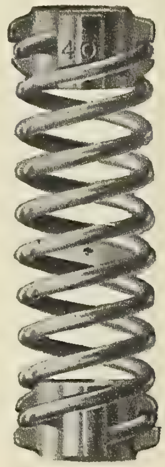


FIG. 14.

FIG. 15.

power is concerned. The piston spring is, therefore, one of the most important single details of the instrument.

Springs are usually rated by the number of pounds pressure which, acting on a ½-inch area piston, will give the pencil a movement of 1 inch, and this quantity is known as the scale of the spring. The following scales are most generally used: 6, 8, 10, 12, 16, 20, 24, 30, 32, 40, 48, 50, 56, 60, 64, 70, 72, 80, 100, 120, 150 and 200. Some engineers prefer to use scales which are even multiples of ten, while others prefer scales which correspond with the divisions of the ordinary rule, as 8, 16, 32. * * * Indicator manufacturers can also furnish instruments whose springs are adjusted to the metric system. When pressures higher than 250 pounds are met with the piston area is usually reduced. Thus with a ¼-inch area piston a 100-pound spring will give the same result as would a 200-pound spring used with a ½-inch piston.

The majority of indicators are fitted with helical piston springs. The following exceptions may be noted, each one representing a class: The Batchelder, having a flat spring; the Keynion, a steam-gage tube, and the Hädike a flexible diaphragm. The two latter have no pistons, but the Hädike is equipped with an auxiliary helical spring.

The helical springs are made of the finest steel wire, tempered by the most experienced workmen. Those made of a single wire are usually wound in a single thread on mandrels, with from four to four and one-half threads per inch, while the double, or so-called "duplex," springs are wound in a double thread with a pitch of about two "turns" per inch.

Fig. 13 shows a much-used form of single spring, and Figs. 14 and 15 double or duplex springs. The springs are generally made a little stronger than necessary, and reduced to the standard by grinding or by screwing them into or out of the

bronze spring heads. It will be noticed that the spring shown in Fig. 15 has but one head, and though wound in a double thread it is made of but a single piece of wire. The bead at the bottom acts as the center member of a ball and socket joint, by which the spring is attached to the piston. This permits of great freedom of movement of the piston relative to the center line of the spring. All springs, of whatever form, are carefully calibrated by the makers before being issued. The process of calibration will be described later. The spring heads are generally threaded on the inside for attachment to the instrument.

(*To be continued.*)

THE NEW HUDSON RIVER STEAMER ROBERT FULTON.

The latest addition to the famous fleet of Hudson River steamboats is the *Robert Fulton* of the Hudson River Day Line, the principal dimensions of which are as follows:

Length between perpendiculars	336 feet 0 inches
Length over all	346 feet 0 inches
Breadth of hull, molded	42 feet 0 inches
Breadth over guards, molded	76 feet 0 inches
Depth, base line to top of deck beams at side of hull at lowest point of sheer	12 feet 4 inches
Crown of deck beams in 76 feet	12 inches
Gross tonnage	2,168
Net tonnage	1,344

The conditions governing the construction of the *Robert Fulton* were unusual, since, not only is she a boat of remarkable design, involving many new features, but also on account of the short time available for her construction it was necessary to use the utmost dispatch in carrying out every feature of the work. The design of the boat was placed in the hands of Frank E. Kirby, D. E., consulting engineer, and J. W. Millard, naval architect. The hull and joiner work were constructed by the New York Shipbuilding Company, Camden, N. J. The machinery and boilers were built by W. & A. Fletcher, Hoboken, N. J., while the interior decoration of the boat was in the hands of Mr. Louis O. Keil.

The hull is of steel and is divided into five watertight compartments by four transverse bulkheads. The frames are of bulb angles, 4 inches by 3½ inches by 8 pounds, spaced 24 inches apart. As this size bar is not rolled in the United States, it was necessary to send to Scotland for the frames. These were ordered even before the contract for building the hull had been let, and it is noteworthy that the material was delivered to the builders within twenty-four hours of the time it was needed. The floors are of flanged steel 12½-pound plate, 15 inches deep, and the main-deck beams are bulb angles, 4 inches by 2½ inches by 8 pounds, placed on every frame. The sheer strake of plating is 17½ pounds by 45 inches wide amidships, gradually tapering to 10 pounds at the bow and stern. In way of the wheel opening the sheer strake is increased to 20 pounds. The bottom and side plating are 12½ pounds amidships, reduced to 10 pounds bow and stern. The landing edges of all outside strakes, except the garboard and sheer strakes, are joggled, doing away with the use of liners.

Throughout the superstructure of the boat the construction is entirely fireproof, steel, asbestos and other non-combustible materials being used exclusively. The strength and rigidity of the structure are secured by means of a system of stanchions between the decks. These are of steel placed in four rows extending practically the whole length of the vessel. By means of connections to the longitudinal girders and deck beams, the entire structure is thoroughly braced to withstand the hogging and sagging stresses set up by the rapid shifting of the load on the boat, which consists almost entirely of passengers, it being necessary to make provision so that the entire complement of 2,000 or more passengers can all be placed either at one end or at one side of the boat, as may be necessary on account of the direction of the wind or position of the sun. This fact also had its effect upon the design of the hull, which must have good stability under all these conditions. This led to the placing of large trimming tanks on either guard just aft of the paddle wheels. These tanks have a capacity of 20 tons of water each, and there is also a ballast tank holding 30 tons of water located in the hold at the stern of the boat.

THE NEW HUDSON RIVER STEAMER ROBERT FULTON.

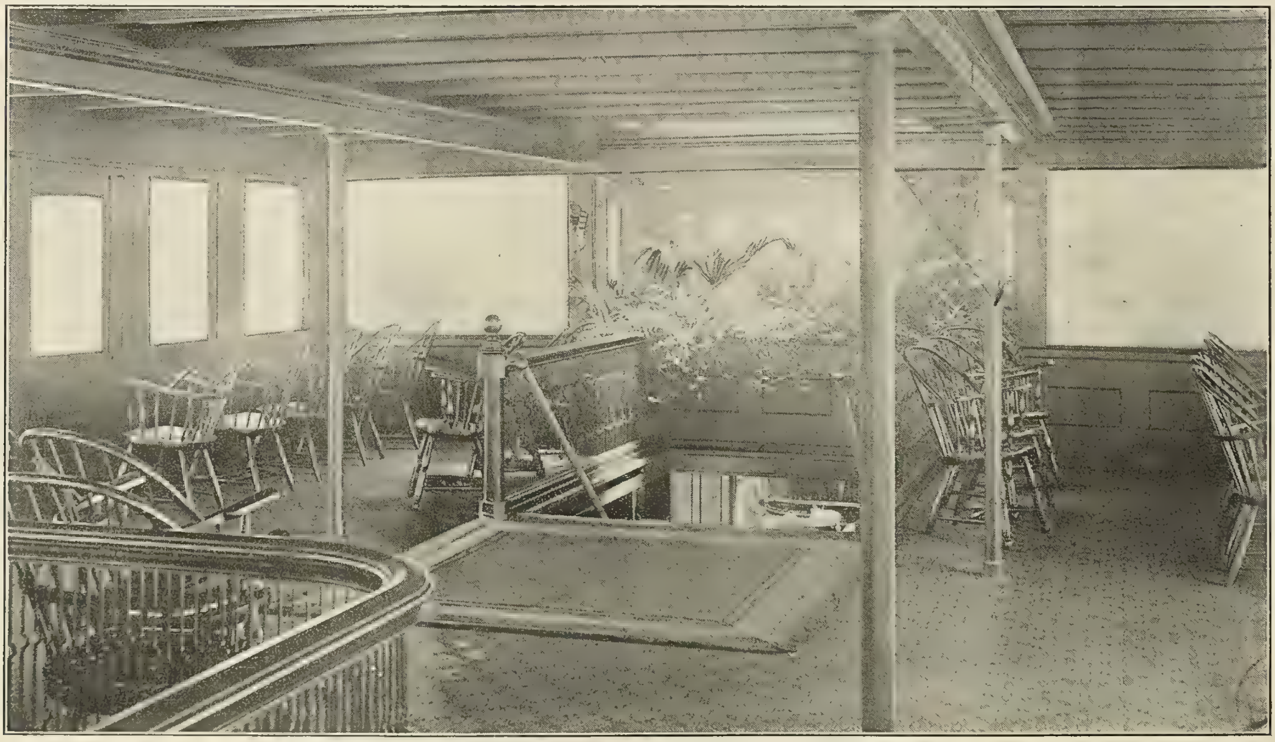
The design of the hull was further complicated by the fact that on a draft of less than 7 feet it was necessary to build a hull of sufficiently fine model, so that a speed of 23 miles an hour could be obtained without the expenditure of an extraordinary amount of power.

The boat is propelled by steel feathering paddle wheels, 30 feet 8 inches diameter at the outside of the rims. The buckets, or paddles, are each 12 feet 6 inches long by 3 feet 6 inches wide. The engine is of the single-cylinder, vertical, surface-condensing walking beam type commonly used on American river steamers. The cylinder is 75 inches in diameter, with a stroke of 12 feet, and runs at about 40 revolutions a minute. The normal speed of the boat is 20 miles an hour, but, under favorable conditions, she can be forced to 23 miles an hour. Steam is supplied by three lobster-back return tubular boilers, each 33 feet long, operating at about 55 pounds pressure per square inch. The total heating surface of the boilers is 5,499 square feet, and the total grate area 228 square feet, making a ratio of heating surface to grate area of 24.1. The

GRAND SALOON OF THE ROBERT FULTON, DESIGNED AS AN ITALIAN GARDEN.

boilers are fitted for both natural and forced draft, the latter being supplied by two Sirocco blowers, each having a double inlet and single outlet. The wheels are each 42 inches in diameter in full casing, so designed as to give a total air delivery of 56,000 cubic feet of air per minute against a pressure of 2½ inches of water, the fans operating at 475 revolutions per minute. Each fan is direct connected to an 8½-inch by 6-inch double-inclosed engine, designed to operate on an initial pressure of 35 pounds per square inch with a high vacuum.

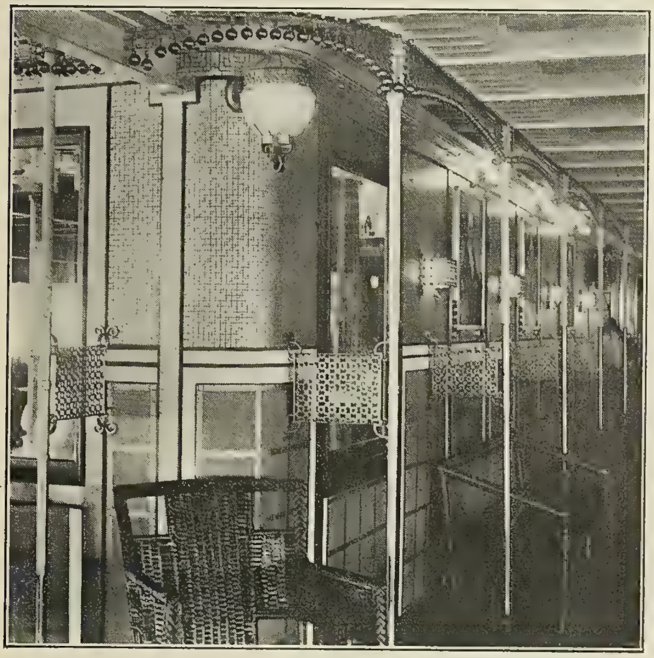
The necessary pumps, ventilating fans and electric generating apparatus are all located on the starboard side of the



ONE OF THE OBSERVATION ROOMS ON THE UPPER DECK OF THE ROBERT FULTON.

engine room. One of the electric generating sets is driven by a Curtis turbine. The donkey boiler is located on the main deck. An elaborate automatic fire alarm system has been installed, including three annunciators, placed in the pilot house, engine room and the purser's office. The alarm is given simultaneously on these three annunciators and by means of bells in the crew's quarters, so that in the event of fire or any other emergency the crew will immediately respond, knowing the exact location of the trouble.

The general arrangement and interior decoration of the boat are both novel and pleasing. The forward part of the hold is utilized for the crew, and aft of this is a lunch room



IRON GRILL WORK IS A FEATURE OF THE INTERIOR DECORATION OF THE ROBERT FULTON.

70 feet long, extending the whole width of the ship. This room is fitted up in ship-cabin style, the dining tables being set against the sides of the hull, each in a separate compartment, with wood benches on each side. The wood used for the furniture and wainscoting is cypress. The combination of the quaint design with the open ports and deck beams overhead gives a very pleasing effect. Just aft of the lunch room is the engine room, and aft of the engine room the boiler room. Separated from the boiler room by a bulkhead is the galley, which is about 34 feet long and contains a complete outfit of ranges and galley accessories, besides a complete refrigerating system.

The forward part of the main deck is entirely inclosed by a deck extension above, while aft are located the hospital, barber shop, toilets, coat and baggage rooms, purser's office, and at the stern of the boat a large dining room, the decoration of which is carried out in Delft blue.

The grand saloon, which occupies the entire saloon deck, is a decided novelty in naval architecture. Instead of the usual style of decoration employed on most sound and river steamers, the saloon is treated as a formal Italian garden with carved pillars, broad balustrades, wide open spaces and irregular nooks, the entire garden being decorated with plants, palms, vines, even canary birds being added to give a touch of outdoor life. Large comfortable wicker chairs are placed throughout the garden. The color scheme of the saloon is white, green and gold. On this deck are placed oil portraits of notable Americans by Robert Fulton Ludlow, great grandson of Robert Fulton, the first marine engineer, and paintings of the old Livingston manor house, of Fulton's first steamboat, the *Clermont,* and the departure of the *Clermont* on her first trip in 1807.

Other paintings include pictures of old cities and towns of the early nineteenth century by Vernon Howe Bailey and Frederick W. Glover, a series of historical paintings showing the development of the steamboat and the various types of sail and other craft that plied on the Hudson in the early days by S. Ward Stanton, and two large decorated wood panels by Raphael A. Weed, depicting Rip Van Winkle's meeting with Hendrick Hudson and Robert Fulton at Clermont. The use of decorative iron work, designed by H. O. Schmidt, also adds much to the beauty of the boat.

The writing room is located amidships, while at the forward end of the saloon deck provision is made for an orchestra on a sunken platform open at the sides, so that the music can be heard on all three decks. Located along the sides, amidships, are ten day-parlors, the walls being decorated with flowers of the Hudson Valley. Each room has a private balcony overlooking the water.

The upper deck includes two large observation rooms, finished in cypress. Large plate-glass windows on three sides of each room give an unobstructed view in every direction.

The keel of the vessel was laid on January 12, and she was launched March 20, the honor of christening the vessel being given to Miss Anita Merle-Smith. The boat had her first trial trip on May 8, sailed for New York on May 20, and went into service on May 29.

A Practical Comparison of the Advantages of Higher Cylinder Ratios.

BY LIEUTENANT C. S. ROOT.

An examination of the cylinder diameters of naval engines will show cylinder ratios varying from 1:4.75 to 1:11.2 in triple-expansion engines of ships of war now in commission. This seems to point to a decided difference of opinion among naval engineers in regard to these ratios, and for this reason it is thought that the following account of two moderately long runs of the same vessel with different cylinder ratios may be of interest.

Passed Assistant Engineer E. T. Warburton, U. S. N., in the *Journal of the American Society of Naval Engineers* (Vol. IX.), describes a trans-Atlantic run of the United States steamer *Bancroft,* from which the following is taken:

"The *Bancroft* was docked and refitted in September (1896) at the navy yard, New York, in ten days, for a cruise on the European station. * * * The *Bancroft* left Tompkinsville, Staten Island, N. Y., Sept. 15, 1896, using both boilers, and arrived at Fayal, Azores, Sept. 25. The dynamo was run about twelve hours, and about 300 gallons of water distilled every day. The vessel started with about 160 tons of bituminous coal on board. Distance steamed, 2,133 nautical miles; time, 10 days 1 hour, or 10.04 days; average speed, 8.85 knots; average revolutions per minute, 124; coal used for all purposes, 102.69 tons; coal per day, 10.22 tons; miles per ton of coal, 20.77. There remained in the bunkers 57.5 tons.

"Left Fayal Sept. 28 and arrived at Gibraltar Oct. 4. Strong head winds were encountered for the greater part of the distance. Distance steamed, 1,136 nautical miles; time, 6 days 3.75 hours, or 6.16 days; average speed, 7.69 knots; average revolutions per minute, 129.2; coal used for all purposes, 59.33 tons; coal per day, 9.63 tons; miles per ton of coal, 19.14.

"Left Gibraltar Oct. 6, and arrived at Smyrna, Asia Minor, Oct. 15. Distance steamed, 1,631 nautical miles.

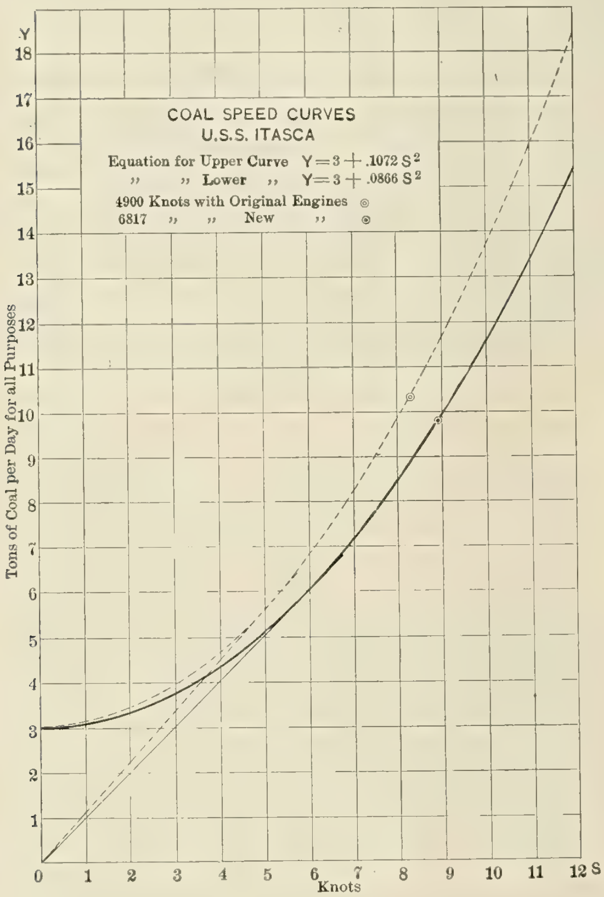
"The coal obtained at Gibraltar was of such very inferior quality that the daily consumption necessarily increased.

"The trip from Tompkinsville to Smyrna (4,900 nautical

miles) in 29.5 days, including stoppage of 2½ days at Fayal and 2 days at Gibraltar, at an average speed of 8.25 knots and an average daily coal consumption of 10.3 tons, is not a bad showing for this little vessel. * * *"

In the run described the vessel was equipped with two gunboat or low-cylindrical boilers, having 2-inch tubes. The total heating surface was 2,686 square feet, and the grate surface 87.75 square feet. Her twin-screw, triple-expansion engines had cylinders 13½, 21 and 31 inches diameter and 20 inches stroke; the maximum designed working pressure being 160 pounds per square inch above the atmosphere.

In January, 1906, this vessel was transferred to the United States revenue cutter service, and her name changed to *Itasca*. During the following winter she was given a thorough overhauling and partial rebuilding. Watertube boilers of the Babcock & Wilcox type, with 2-inch tubes, were installed.



The boilers have a total heating surface of 3,825 square feet and a grate surface of 85 square feet. The matter of cylinder ratios was carefully gone over. New cylinders were designed to give a maximum card factor and minimum terminal pressure while maintaining the same referred mean effective pressure that obtained in the old arrangement. The most suitable diameters were found to be 12 and 19 inches for the high-pressure and medium-pressure cylinders. The low-pressure cylinders were not changed. The "main-engine" auxiliaries, which included an independent, twin-cylinder, single-acting air pump, remained as before, but a larger electric generating set was installed, as was also a larger fan for forced draft and ventilation. A feed-water heater was added to her equipment, and the maximum steam pressure raised to 215 pounds per square inch above the atmosphere. The propellers remained as before, and the vessel was ballasted to bring her down to her original displacement.

After the trial trips the vessel was taken to the revenue cutter service yard at Arundel Cove, Md., and hurriedly equipped for sea. She left there on July 20, 1907, and called at New York, N. Y., and New London, Conn. She coaled at the latter place, and, leaving there on July 28, arrived at Ponta Delgada, Azores, Aug. 7. The data obtained on this part of the voyage were unreliable, for reasons which it is not necessary to enumerate here, and these data will not be included in the figures used hereafter. The *Itasca* left Ponta Delgada Aug. 9, called at Gibraltar, Marseilles, Naples, Algiers, Funchal (Maderia), and arrived at St. Thomas, Danish West Indies, Sept. 27. Total running time, 765.6 hours (31.9 days); total distance steamed, 6,817 nautical miles; total coal consumed for all purposes, 314.5 tons; average steam pressure, 152 pounds per square inch. An average of 700 gallons of water was distilled every day. The coal obtained at Algiers was of the poorest quality, and it was difficult, at times, to maintain the low speed fixed for the voyage. This coal lasted for upwards of 2,000 miles.

The *Bancroft* had strong head winds from the Azores to Gibraltar, and the *Itasca* encountered a gale in the Gulf of Lyons. On each voyage the vessel was handicapped by bad coal for portions of the run. While the *Itasca* distilled more water per day than the *Bancroft*, this was more than balanced by the feed heater. The weather during both runs was uniformly good, except as noted above.

Here we have two long runs at low speeds with practically no change in the vessel, except in the high-pressure and medium-pressure cylinders of the main engines and the addition of a heater, for which a definite allowance can be made. The conditions for comparison seem to be almost as favorable as could be desired. To sum up the two voyages, we have:

	Bancroft.	*Itasca.*
Ratio of the net piston areas..........	1:2.4:5.3	1:2.5:6.8
Grate surface, square feet.............	87.75	85.0
Time out of drydock at beginning of voyage, months..................	0	2
Total distance, nautical miles.........	4,900	6,817
Average speed, knots.................	8.25	8.9
Average coal consumption, tons per day	10.3	9.86
Water distilled, gallons per day.......	300	700
Dynamo in operation, hours per day...	12	12

In an article published in Vol. XV. of the *Journal of the American Society of Naval Engineers*, Lieut. D. S. Mahony, United States navy, has shown that, if the relation between coal consumption and speed follows any law it is probably as follows:

If rectangular co-ordinates be used, speed in knots plotted as abscissæ and coal consumption in tons per day as ordinates, the curve thus found will differ very little, if at all, from a curve satisfying the equation $y = c + kx^2$. From data in Lieut. Mahony's article is deduced the fact that the actual plotted values of the coal-speed curves of a large number of vessels of the United States navy did not vary, on an average, from the form $y = c + kx^2$ by more than 3 percent, the maximum variation being 6.4.

This form of curve will, therefore, be used in making the comparison.

Let y = the coal consumption in tons per day for all purposes at the speed s.

c = the coal consumption in tons per day for all purposes at zero speed, *i. e.*, with all the usual auxiliaries in operation and the engines kept well "warmed up," making, say, 400 revolutions per hour.

k = a constant which must be computed for each vessel.

s = the speed of the vessel in knots.

Then will $y = c + ks^2$.

In the case of the 4,900-mile run of the *Bancroft* we have: $y = 10.3$, $c = 3$, $s = 8.25$. Hence, $y = 3 + .1072\ s^2$. For the 6,817-mile run of the *Itasca:* $y = 9.86$, $c = 3$, $s = 8.9$. Therefore, $y = 3 + .0866\ s^2$.

The value of c was taken from the naval records. These curves have been plotted and are shown on the accompanying diagram. The difference in coal consumption is seen to be in favor of the later arrangement of machinery, and at 9 knots is equal to $(3 + .1072 \times 9^2) - (3 + .0866 \times 9^2) = 1.67$ tons per day.

The feed heater raised the temperature of the feed 80 degrees F., and, taking the evaporation as 8 pounds of water per pound of coal—which seems ample in view of the quality of coal used throughout the voyage—a simple calculation will show that about one-third of the 1.67 tons of coal saved per day was due to the heater. The remainder of the saving cannot be accounted for unless it be credited to the superior economy of the new cylinder ratio of the propelling engines.

The following facts in regard to this particular steam plant are brought out by the above comparison and the trial data of the vessel:

1. The engines with the larger cylinder ratios developed higher power on a slightly smaller grate surface.
2. They have shown greater economy at low speeds.
3. The weight of the engines is a little less, due to the reduction of the high-pressure and medium-pressure cylinder diameters.

The substantial increase in economy, due to a small increase in cylinder ratios and steam pressures, is again illustrated in the case of the United States steamers *Newport* and *Annapolis.* Their hulls are similar, as shown below, both vessels being composite and sheathed with copper:

	Newport.	*Annapolis.*
Length between perpendiculars, feet	167.75	168.0
Beam, molded, feet	36	36
Mean draft, feet	12	12
Displacement, tons	1,010	1,017
Area of immersed 'midship section, square feet	354	357
Block coefficient	.482	.49
'Midship section coefficient	.82	.82
Load waterline coefficient	.743	.74

Their engines are as follows:

Newport—Jacketed: Cylinders, diameter, 13½, 23½, 36 inches; stroke of pistons, 30 inches; ratio of high pressure to low pressure by net piston areas, 1 : 5 : 67.

Annapolis—Not jacketed: Cylinders, diameter, 15, 24½, 40 inches; stroke of pistons, 28 inches; ratio of high pressure to low pressure by net piston areas, 1 : 7 : 27.

The following data are from cards taken on the official trials:

	Newport.	*Annapolis.*
Pressure at boilers, pounds per square inch, gage	177	224
M. E. P. referred to L. P. cylinders	42.8	46.58
Piston speed, feet per minute	684.25	686
Indicated horsepower	904	1,217
Terminal pressure of the P. V. curve from combined diagram	20.3	18.63
Water per I. H. P. per hour	15.39	13.33

The superior efficiency of the machinery of the *Annapolis,* as shown by the water rate above, was afterwards maintained in service. Another point indicated by these data is, that had the *Annapolis* been fitted with a 36-inch low-pressure cylinder, the cylinder ratios remaining as before, they would have developed power equal to the *Newport* and must have weighed less. These results check with the runs of the *Bancroft* and *Itasca* described above.

Data, from runs made at low speeds, and selected because of similarity of conditions, are given below:

	Newport. July, 1908.	*Annapolis.* Aug. & Sept., 1908.
Months out of drydock	7	16
Fore and aft sail set, percent of time	50	50
Bunker capacity, tons	232	222
Full-load displacement, tons	1,128	1,116
Duration of the run, hours	156	257.3
Speed, in knots	8.1	8.2
Nautical miles, per ton coal	17.4	26.97
Endurance, days	19	30.4
Nautical miles	3,722	5,987

S. S. GEORGE WASHINGTON.

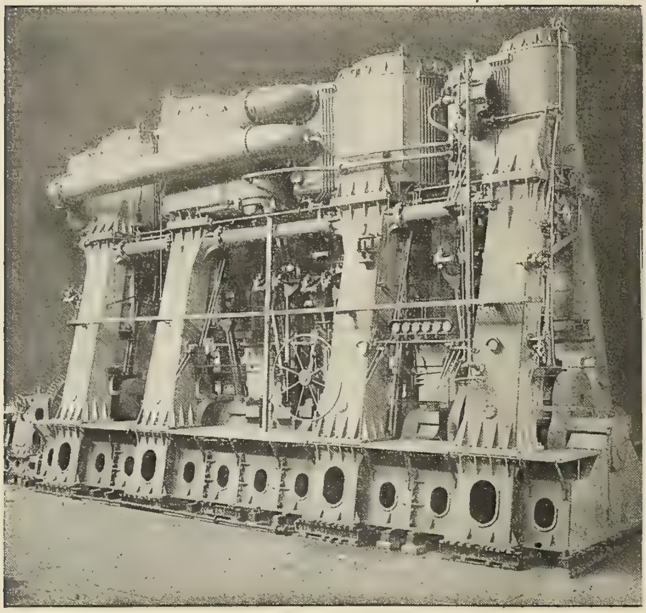
The latest addition to the transatlantic fleet of the North German Lloyd Line is the *George Washington,* of 27,000 gross tons, built by the Stettiner Maschinenbau-Actien-Gesellschaft "Vulcan," Stettin-Bredow. She is the largest vessel ever built in Germany, the principal dimensions being as follows:

Length over all	722 feet 5 inches
Length between perpendiculars	697 feet 6¼ inches
Length on water line	700 feet 0 inches
Beam	78 feet 0 inches
Depth from upper saloon deck	54 feet 0 inches
Depth from awning deck	80 feet 0 inches
Draft	33 feet 0 inches
Displacement at above draft	36,000 tons
Horsepower	20,000
Speed	18.5 knots

The *George Washington* is a first-class twin-screw passenger and freight steamship, with a straight stem, semi-elliptical stern, two funnels and four pole masts. The hull is of steel, built to the highest class of Germanischer Lloyds, and has a double bottom extending throughout the entire length of the ship. Twelve watertight bulkheads subdivide the ship into thirteen watertight compartments. Eight of these bulkheads extend up to the upper deck and four to the lower promenade deck. The Stone-Lloyd system of watertight doors is used in all the watertight bulkheads, there being 36 doors in all.

The vessel is propelled by twin screws, 21.33 feet diameter and 24.93 feet pitch. The blades, of which there are four on each propeller, are adjustable and can be arranged to give an increased pitch up to 26.58 feet. Each propeller is driven by a four-cylinder quadruple expansion engine having cylinders 38.19, 56.69, 79.92 and 112.21 inches in diameter, with a stroke of 66.93 inches. At 86 revolutions per minute, using steam at 220 pounds per square inch, the engines develop approximately 10,000 horsepower each, driving the ship at a speed of 18.5 knots. On her trial trip a speed of 20 knots was attained, the engines developing nearly 22,000 horsepower. The arrangement of cylinders in the engine is, from forward aft: high-pressure; second-intermediate; low-pressure; first-intermediate. The high-pressure and first-intermediate cylinders each have a single piston valve, the second-intermediate has two piston valves, and the low-pressure cylinder a flat slide valve. The diameter of the crank shaft is 22.25 inches, the tunnel shafting, 20.39 inches, and the tail shaft 22.09 inches. Each engine has a separate surface condenser, having 12,930 square feet of cooling surface. The air pumps are 10 by 32.99 inches by 20.98 inches stroke, and the circulating pumps 12.21 by 51.18 inches by 9.84 inches stroke.

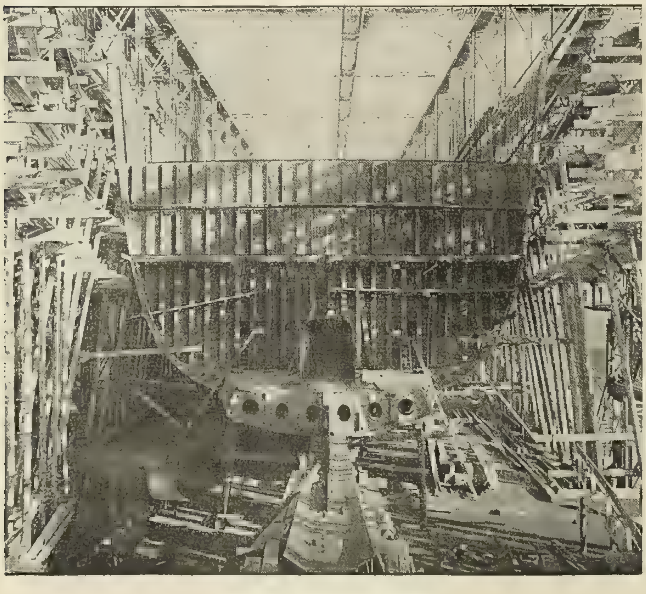
Steam is furnished by eight double-ended and four single-ended Scotch boilers, placed in two separate fire-rooms. All



ONE OF THE MAIN ENGINES.

the boilers are 15.75 feet in diameter, the double-ended boilers being 20.34 feet long and the single-ended boilers 11.98 feet long. Each double-ended boiler has six corrugated furnaces leading into three separate combustion chambers. There are seven hundred and fifty-six tubes, 3 inches outside diameter, making a total heating surface for the double-ended boilers of 5,200 square feet. Each single-ended boiler has three corrugated furnaces, leading to three separate combustion chambers, and three hundred and seventy-eight tubes, 3 inches outside diameter, making a total heating surface of 2,710 square feet for each single-ended boiler. Howden's forced draft is used, giving a pressure in the ash pits equivalent to 1.97 inches of water. The ship has a bunker capacity of 3,900 tons, with a reserve supply of 900 tons. Four ash ejectors supplied by Howald, of Kiel, are fitted in the boiler rooms.

Electricity for lighting and power throughout the ship is generated by seven separate steam-driven direct-connected generators, each having compound engines of 200 horsepower, with cylinder diameters of 12.60 and 22.05 inches and a stroke of 9.84 inches, operating at 220 revolutions per minute. The generators are each of 110 kilowatts capacity.

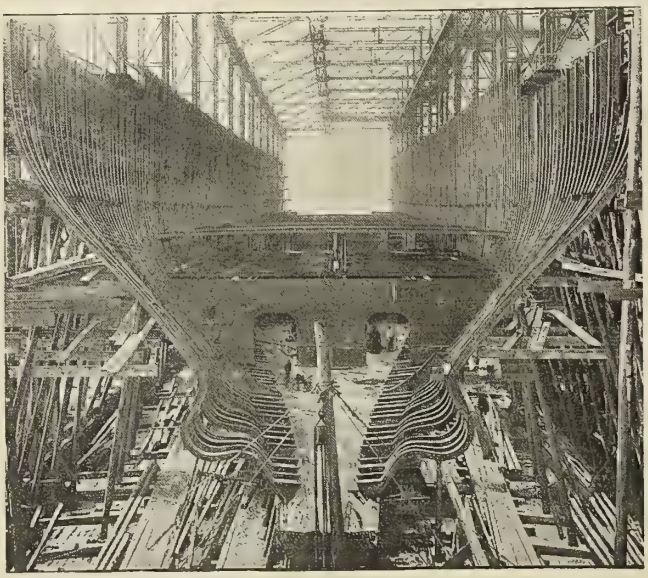


BULKHEAD CONSTRUCTION.

Ventilation is by thirty electrically-driven Sirocco fans. The auxiliaries include six boiler-feed pumps, 17.32 by 12.60 inches, with a stroke of 26.57 inches and a capacity of 65 tons per hour. There are two steam-driven bilge pumps, each of which has a capacity of 102 tons per hour, the size of cylinders being 7.09 and 8.66 inches, and the stroke 13.78 inches. There are two other bilge pumps direct connected to the main engines, each of which has a diameter of 7.09 inches and a stroke of 21.65 inches. There are three centrifugal fire pumps, having a capacity of 8,480 cubic feet per hour, maintaining a pressure of from 118 to 147 pounds per square inch in the pipes. One hundred and fifty couplings for the attachment of hose are distributed throughout the vessel.

Two ballast pumps are provided, 8.66 by 11.81 by 13.78 inches, each having a capacity of 150 tons per hour; also sanitary pumps having a capacity of 190 tons per hour and three pumps for supplying water to the baths, one of which is steam driven, the other two being direct connected to the main engine. The steam-driven pump is 5.51 by 7.09 by 9.84 inches; and the direct-coupled pumps 5.91 by 21.65 inches.

Fresh water for the boilers is supplied by an evaporator having a capacity of 50 tons per twenty-four hours, while fresh drinking water is supplied by two evaporators, each having a capacity of 20 tons per twenty-four hours. The refrigerating plant includes one large machine and one auxiliary machine. The large machine is operated by a compound en-



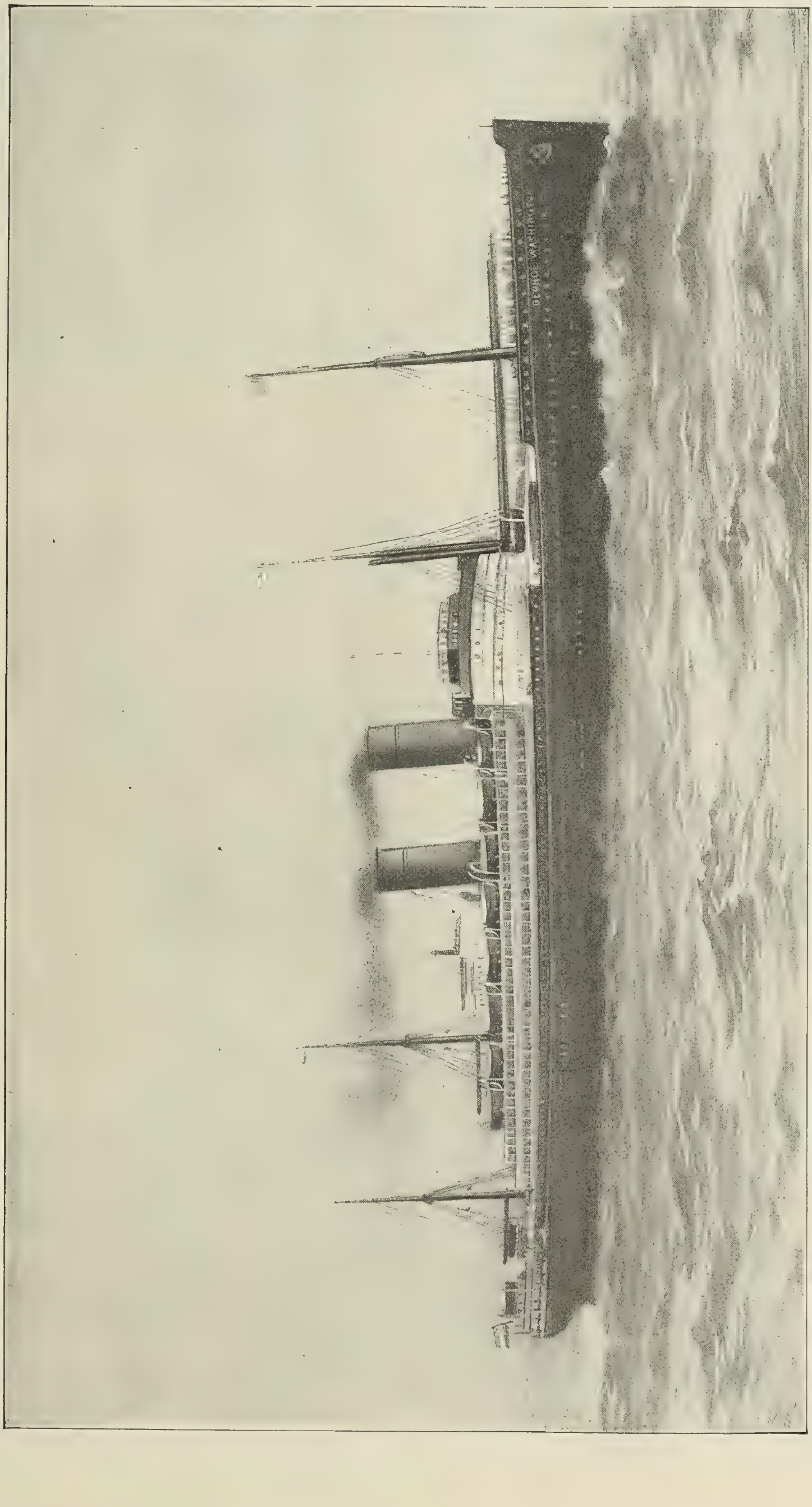
STERN FRAMING OF THE GEORGE WASHINGTON.

gine having cylinders 9.84 and 15.75 inches diameter, with a stroke of 11.81 inches. The small machine has a cylinder diameter of 5.91 inches and a stroke of 6.89 inches.

Cargo is handled through five cargo hatches, three forward and two aft, the deck machinery including 19 cargo winches, 1 capstan and 5 steam-driven windlasses. The cargo winches are driven by 7.89 by 13.78-inch engines. The windlasses are driven by simple engines having cylinder diameters of 13.78 inches and a stroke of 12.21 inches. The capstan is driven by a simple engine having a cylinder 18.50 inches in diameter and a stroke of 14.17 inches.

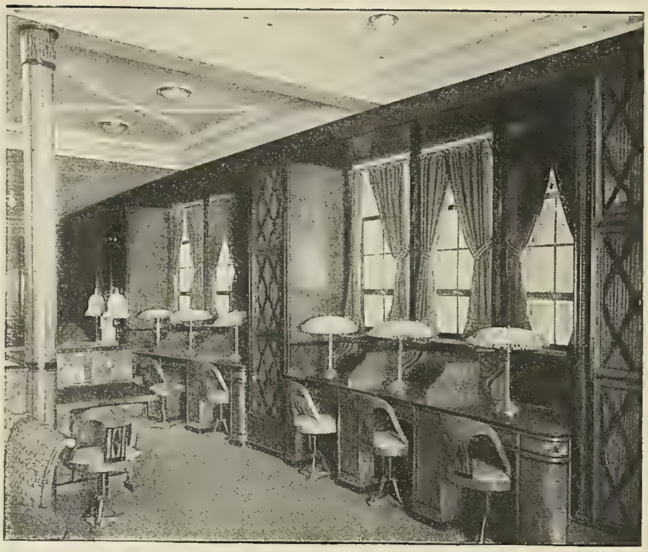
The steam steering gear consists of a Brown steam tiller and telemotor. The engine has two cylinders, each 12.99 inches in diameter, with a stroke of 11.81 inches.

The engine-room force on the ship consists of one chief engineer, one first engineer, two seconds, four thirds, four fourths and eight assistants. There are also four electricians,



THE NEW NORTH GERMAN LLOYD LINER GEORGE WASHINGTON, THE LARGEST STEAMSHIP EVER BUILT IN GERMANY.

INTERIOR OF THE SMOKING ROOM.



A CORNER OF THE WRITING ROOM.

six oilers, two storekeepers, one plumber and one boiler maker. The fire-room force includes six head stokers, sixty stokers and sixty-three trimmers.

Accommodation is provided on the vessel for first, second and third class and steerage passengers. The first class accommodations are all on the upper decks, amidships, with the second class aft on the upper and lower promenade decks. The steerage passengers are placed forward, while the third-class quarters are at the stern of the boat.

The arrangement and decoration of the first-class public rooms and staterooms have been carried out in a pleasing manner. The rooms are almost without exception of good height and tastefully paneled in natural wood. The first class dining room, in the center of which there is a well extending up through two decks, is especially attractive, the color scheme being red, white and gold.

The reading room, situated on the upper promenade deck, is decorated in quiet tones and writing tables and book cases

FIRST CLASS DINING-SALOON OF THE GEORGE WASHINGTON.

are arranged around the walls and in the center of the room. The effect of great spaciousness has been obtained in this room by letting the book cases into the walls between the writing tables.

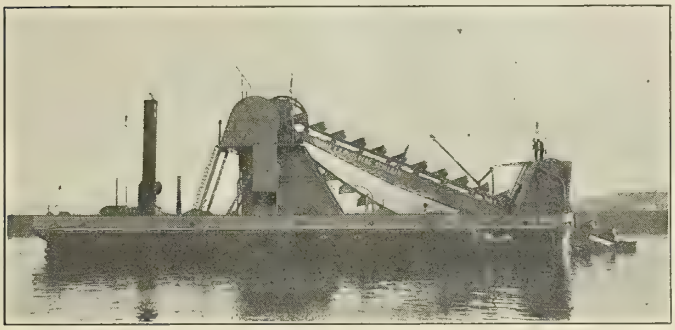
Numerous mural paintings, depicting the life and times of President Washington, have been supplied by Otto Bollhagen, of Bremen, who spent considerable time in the United States studying the scenes and history of the events portrayed.

Among the unusual features installed on the boat are two electric elevators, a large, well-appointed gymnasium and a nursery; also on the boat deck there are two specially-constructed dog kennels in charge of a competent kennel master.

Welin quadrant davits are used exclusively for handling the ship's boats.

BUCKET DREDGES No. ONE AND LA PLATA.

The bucket dredger *No. 1* is a type of stationary dredger built by the Werf Gusto, Shiedam, Holland, for the port of Copenhagen, while *La Plata* is a type of seagoing twin-screw bucket dredger, built by the same concern for Argentine. *No. 1* is 111 feet 6 inches long, with a beam of 26 feet 9 inches and a depth of 9 feet 9 inches, with a capacity of 275 cubic yards of material an hour. She was especially designed for dredging clay and other rough material. Electric lighting is used throughout the vessel.



BUCKET DREDGE NO. 1.

La Plata is 169 feet long, with a beam of 30 feet 6 inches and a depth of 12 feet 6 inches, with a capacity of 825 cubic yards of material an hour, dredging from a depth of 42 feet 7 inches.

The hull is divided into nine watertight compartments by means of eight bulkheads. The vessel is propelled by twin screws driven by two compound engines developing 260 indicated horsepower each, with surface condensation. Each of these engines may separately drive the bucket chains for dredging, and, while navigating, each engine drives one of the twin screws, giving the vessel a speed of about 7 knots. The auxiliary engines include five steam winches for the maneuvering chains fore and aft, for handling the anchors, for the hoisting of the bucket ladder and the chutes; an engine for driving the dynamo and a direct-working 6-inch centrifugal pump for supplying water to the chutes.

Steam is supplied by two boilers of the Scotch marine type, having a total heating surface of 2,600 square feet and a working pressure of 120 pounds per square inch.

The buckets each have a capacity of 25 cubic feet, so that when working at a speed of fifteen buckets a minute the dredger has a theoretical capacity of about 825 cubic yards per hour.

La Plata made the voyage from Europe to Buenos Ayres in forty days, and is to be used in deepening the harbors of Buenos Ayres and Rosario.

THE PROPULSION OF SHIPS BY MEANS OF CONTRARY TURNING SCREWS ON A COMMON AXIS.*

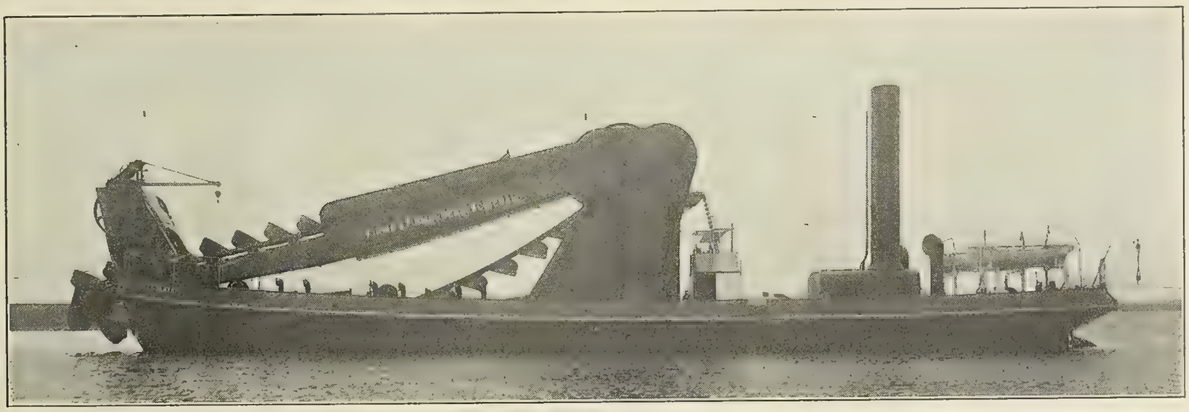
BY LIEUTENANT-COLONEL G. ROTA, R. I. N.

The method of propulsion by two contrary turning propellers on a common axis was first applied to marine purposes by Ericsson in the *Robert F. Stockton* in 1839. More recently we have had a general application of the same principle in the well-known Whitehead and similar torpedoes. In 1892 a little steamboat for passenger traffic on the Brent Lake (Neuchâtel) had a similar engine working the propellers by means of gear under the patent of Stengen, of Strasbourg. Another similar patent† was claimed for a double propeller on a common axis, in association with an oil engine and belt drive.

The guide blade of Thornycroft's system, and also the systems of Rigg and Parsons, can be considered as special cases of the double propeller arrangement, the after screw being replaced by guide blades. At the time that the above arrangements were devised, the reciprocating engine was the only kind of engine available for marine propulsion, and it was only possible to drive one of the two shafts (the inner one) off the engine, as no arrangement of gearing or belt driving was found to be practically workable for the outer propeller. The working screw was therefore placed in front of a fixed-blade device, which acted as a guide to divert the stream of water issuing from the screw in parallel lines astern.

But the fixed guide blades, independently of their beneficial influence on the efficiency, certainly increase the resistance of the hull. It is well known, however, that this increase of

* From a paper read before the Institution of Naval Architects, April, 1909.
† Described in INTERNATIONAL MARINE ENGINEERING, September, 1907.
‡ Trans. I. N. A., Vol. XXIX., p. 319.



BUCKET DREDGE LA PLATA.

resistance can be reduced if the guide blades are not fixed, but form instead an integral part of the propelling apparatus. With such an arrangement the stream of water is conveyed to the after part of the propeller in a more convenient direction, thus ensuring the beneficial influence of that propeller on the forward one.

In his interesting paper of 1888,‡ Prof. Greenhill, in explaining his theory of the screw propeller, first analyzed the case of the double-screw propeller on a common axis, and pointed out the maximum efficiency it would be possible to obtain by a special arrangement for increasing the pitch of the screws. I venture to say that a gain of efficiency is generally obtained by the double-screw propellers on a common axis, not as a consequence of increasing the pitch under the Greenhill arrangement, but merely by the sub-division of the propeller into two parts acting in opposite directions, yet of constant pitch.

As the result of careful observations it may reasonably be assumed that an increase of efficiency is possible with the above arrangement of propellers instead of the ordinary single screw. It is well known that with an hydraulic turbine an essential condition to get good efficiency is to have the water

(4) Increase in the depth of water above the propellers, that causes another gain of efficiency.

Other beneficial effects will ensue when considering the question from the point of view of maritime and inland navigation.

Until now, although the arrangement of double contrary turning screws on a common axis is not new, its superiority as compared with the single screw has not yet been demonstrated in a practical manner. That has been the subject of my researches, and I am indebted to H. E., the Minister of Marine in Rome, for having permitted me to carry out a complete series of trials with a steamboat in the Royal Dockyard at Castellammare di Stabia, first with a single screw and afterwards with two contrary turning screws of different diameters on a common axis with a constant pitch, and also with increasing pitch according to Professor Greenhill's rules. The results obtained by these trials showed that a great gain of efficiency is to be expected with the double screws. It appears that about 20 percent of the horsepower can be saved.

In the experimental arrangement on the vessel which I had at my disposal for the trials, the two shafts are driven by gearing off the reciprocating engine, and the loss of power

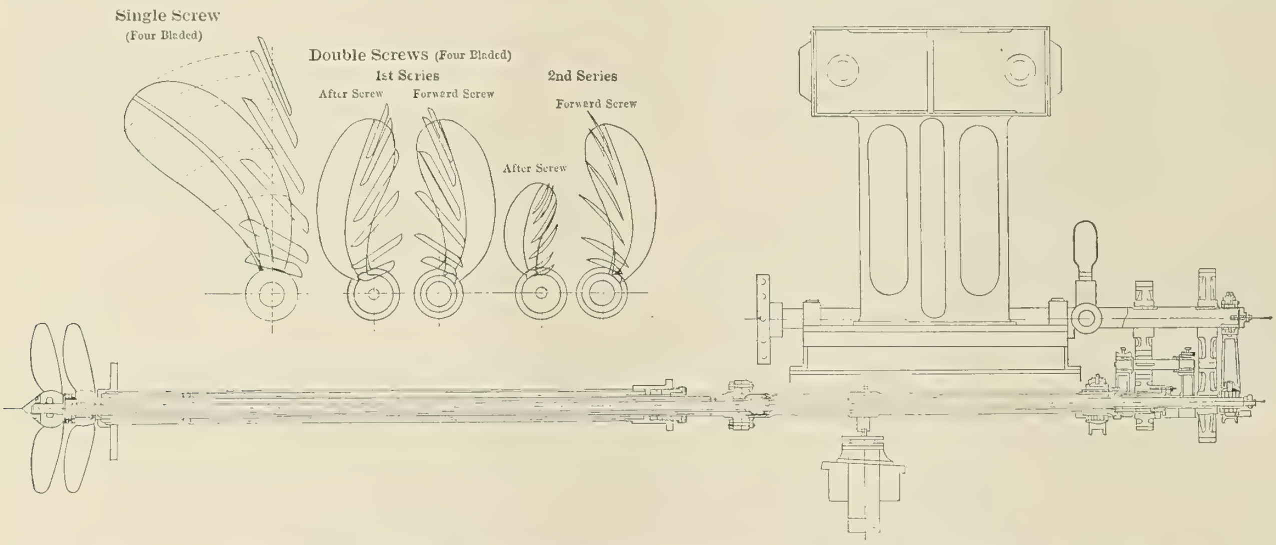


FIG. 1.—SHAPE AND DIMENSIONS OF THE SCREWS, AND GENERAL ARRANGEMENT OF ENGINE, SHAFTS, BEARINGS AND GEARS ON STEAMBOAT.

conveyed by the guides before acting on the buckets; in that case the guides evidently act in the same way as the forward screw on the after one. Similarly, with steam turbines it is necessary, in every case, to have the acting fluid diverted from its ordinary course, and conveyed to the principal part of the moving apparatus in a direction more conducive to efficiency.

Turning to the question of the reciprocal influence of hull and propeller, a most convenient result is obtained with the double contrary turning screws on a common axis instead of the ordinary single screw.

(1) Because the increase of resistance caused by the action of the double propellers is lessened when compared with that obtained by the single screw, in consequence of the smaller diameter of the screws.

(2) Because the gain in wake is considerable in the case of the double screws.

Comparing the above arrangement of screws with ordinary twin screws, we also get:

(3) Reduced length of bracket for propeller shafts, and consequently great reduction in the resistance caused by brackets, which commonly produce a great additional resistance to the hull;

by friction should be taken into account in estimating the probable gain resulting from the use of the double screws. Considering the improvements that should be possible in designing a complete installation on the double-screw system, there is no doubt that a considerable gain in efficiency may be secured.

The main difficulty in the use of two propellers, one behind the other, and acting in contrary directions, may be now surmounted by the use of turbine engines, by which it would be possible to drive in opposite directions two shafts with a common axis, without gearing, belt, or other driving apparatus which is unsuitable for use on board ship. It might also be tried if the combination of steam turbines and reciprocating engines could be conveniently arranged to drive respectively the outer and the inner shafts, connected with the forward and the after screws respectively. The special turbine for reversing would thus be dispensed with, and the other advantages claimed for the "combination system" of machinery would be secured.

The special arrangement of propellers I have described is also of advantage in disposing of the conflict between steam turbines and screw efficiency. It is well known that steam turbines used on board ship cannot be so efficient as those

used for land plants, it being impossible on board ship to have the high rate of revolution required for the highest possible efficiency. The screws have to be reduced in diameter, and consequently their efficiency is lowered, compared to that of the single screw driven by reciprocating engines. The special arrangement of propellers, the one behind the other, which I have described, allows of a greater number of revolutions, and consequently produces a higher efficiency of the steam turbines, and yet, with the reduced diameter of the screw, it allows a considerable increase over the propeller efficiency than is possible with a single screw. If, as I believe, the gain in power were not less than 20 percent in a cruising ship of moderate size, say, 10,000 tons, about 250 tons would

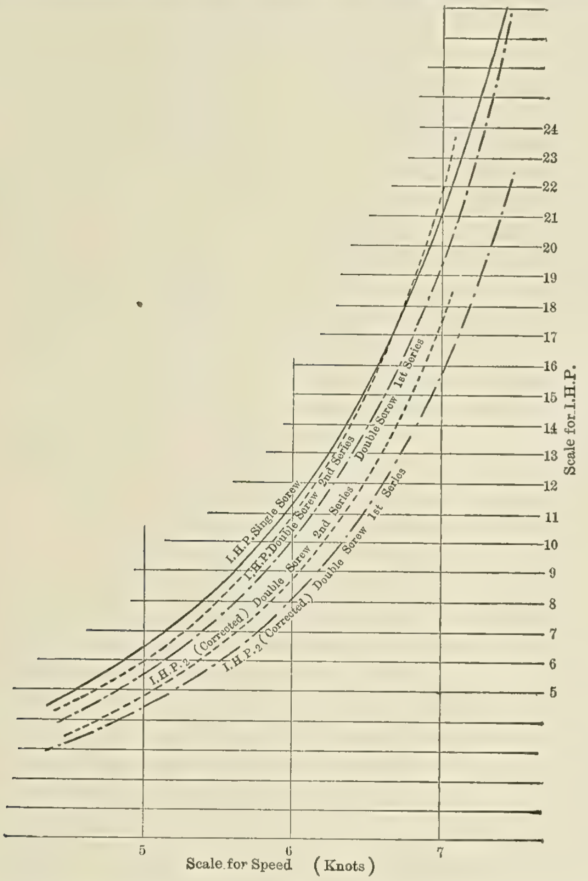


FIG. 2.—COMPARATIVE RESULTS WITH SINGLE AND DOUBLE SCREWS.

be saved in weight of machinery required to obtain 22½ knots, or, on the other hand, a knot more speed could be obtained with the same horsepower.

The arrangement for a large installation of two shafts on a common axis and turning at high speed would, no doubt, involve difficult practical problems. The most convenient design of bearings for both shafts, the reliability of the apparatus, the maintenance of the different parts, the special structure of the hull in the vicinity of the shafts to prevent water entering in case of accident to the shafts, the lubricating arrangements, etc., should all be subjects of careful inquiry. The experimental arrangement of shafts and propellers which I installed on the steamboat for trials has, however, been working satisfactorily for a period of about a year in the ordinary service of the boat.

The boat on which the trials were carried out was of 25 tons displacement, 46 feet (14 meters) long, 11 feet 9 inches (3.6 meters) beam, equipped with a boiler having a total grate surface of 7.64 square feet (.71 square meter); heating surface, 224 square feet (20.8 square meters), supplying steam at a pressure of 75 pounds per square inch (5.3 kilograms per square centimeter) for an engine having cylinders 7.87 inches (.2 meter) in diameter with a stroke of 7.08 inches (.18 meter). The general arrangement of the engine, shafts and propellers is shown in Fig. 1.

Trials were first made with a single four-bladed screw 3 feet 9¼ inches (1.15 meters) in diameter, with a constant pitch of 4 feet 5 inches (1.35 meters). The double screw trials were run in two series with different propellers. In the first series the propellers were of similar shape to that used for the single screw, the combined blade area of the two screws equalling the blade area of the single screw and the number of revolutions being two times the corresponding number for the single screw. These screws were 2 feet 8 inches (.814 meter) in diameter, with a constant pitch of 3 feet 1½ inches (.954 meter).

In the second series of trials with double screws, the propellers were of the same general shape as the single screw, with a pitch according to Professor Greenhill's rules. The dimensions of the after screw were as follows:

	Feet.	Inches.	Meters.
Diameter	1	8¼	.516
Mean pitch	2	3	.69
Initial pitch	1	7	.485
Final pitch	3	10	1.17

The dimensions of the forward screw were:

	Feet.	Inches.	Meters.
Diameter	2	7	.791
Mean pitch	3	5¾	1.06
Initial pitch	2	11¼	.895
Final pitch	4	3	1.3

Fig. 2 shows the comparative results of the three series of trials and the corrections for extra loss of power for friction in the case of double screws as compared with single screws. The value of that extra loss of power for all speeds was estimated at 20 percent of the corresponding horsepower.

The advantage of the double contrary turning screws on a common axis is shown in the following table:

DOUBLE SCREW IN USE.

Speed of the Boat Knots	Single Screw in Use I.H.P.$_1$	First Series. I.H.P.′	Extra Loss of Power for Friction Deduction.	I.H.P.$_2$′ (Corrected).	Gain of Power $\frac{\text{I.H.P.}_1\text{-I.H.P.}_2'}{\text{I.H.P.}_1}$. 100 Percent.
5	6.3	5.45	1.09	4.36	30.5
5½	8.3	7.32	1.46	5.86	29.4
6	11.1	10.	2.	8.	28.
6½	15.15	13.7	2.74	10.96	27.6
7	21.	19.2	3.84	15.36	26.8

DOUBLE SCREW IN USE.

Speed of the Boat Knots	Single Screw in Use I.H.P.$_1$	Second Series. I.H.P.″	Extra Loss of Power for Friction Deduction.	I.H.P.$_2$″ (Corrected).	Gain of Power $\frac{\text{I.H.P.}_1\text{-I.H.P.}_2''}{\text{I.H.P.}_1}$. 100 Percent.
5	6.3	6.	1.20	4.80	23.8
5½	8.3	7.90	1.58	6.32	23.8
6	11.1	10.80	2.16	8.64	22.1
6½	15.15	15.	3.	12.	20.8
7	21.	21.70	4.34	17.36	17.3

The Japanese Mercantile Marine.

In 1889 Japan had 3,536 merchant steamers, aggregating 768,538 tons. In 1908 the number of steamers had increased to 6,098, and the tonnage to 1,494,676. The increase in Japan's mercantile marine during the past ten years has been as follows: 1899, 3,536 steamers, 768,538 tons; 1901, 4,534 steamers, 902,190 tons; 1903, 4,624 steamers, 977,308 tons; 1905, 5,089 steamers, 1,260,087 tons; 1907, 5,784 steamers, 1,462,718 tons; 1908, 6,098 steamers, 1,494,676 tons.

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What Would You Do?

As chief engineer of a steamship, what would you do if the low-pressure cylinder head cracked while the vessel was under way? If a furnace collapsed, or a tube burst, what would you do? What would you do with a vessel whose boilers primed excessively, or with one where corrosion was particularly active in the boilers in spite of every precaution that could be taken? What would you do if the tail shaft broke, or if the propeller dropped off, necessitating the fitting of a spare shaft and propeller? How would you repair a cracked tube sheet while at sea? In the event of the condenser or circulating pumps failing, how would you rig up a jet condenser? Could you build a makeshift pump piston to replace a broken one? What would you do if a fracture developed in the main steam pipe or in any of its valves and fittings?

Questions such as these are not mere matters for idle speculation while coaling ship or lying-to in a safe harbor, but they are questions which frequently call for immediate answer under the most trying circumstances. Breakdowns are bound to occur even on ships where the greatest care is used in the maintenance of the machinery, and it is absolutely necessary that the chief engineer and his assistants should be men competent to face and solve such problems in a satisfactory way. Aside from the fact that it takes a good mechanic to plan and execute a satisfactory repair job on any piece of machinery, the quality most to be desired in a marine engineer, who is likely to be called upon to face such emergencies, is resourcefulness.

Outside of a natural aptitude for mechanics and a thorough training in steam engineering and allied subjects, the thing which makes one engineer more resourceful than another is the fact that he has a wider knowledge of what has been done by other men in similar circumstances on other ships. Stories of breakdowns and how they were repaired are seldom brought to the public notice, on account of the natural reticence of shipowners and marine engineers regarding accidents which have happened to their ships, and consequently the opportunities for most engineers to obtain such information are somewhat limited. During the past few months we have had an opportunity to secure complete details covering a considerable number of repair jobs, several of which are described in this issue. These will be followed by others of the same general character in subsequent issues, and we hope that these few instances will serve to bring forth many more similar articles from our readers.

Superheated Steam.

Superheated steam is no novelty. For over half a century it has been used to a greater or less extent in steam-power plants of all descriptions. During this time it has been the subject of extended and thorough investigation not only as to its individual properties and behavior under various conditions, but more particularly in connection with its use as a factor of economy in steam-power plant design. The whole subject has been so thoroughly discussed time and time again that it would be superfluous to again refer to it if it were not for the fact that current progress in the development of steam boilers and engines is continually bringing forth new conditions and questions in relation to the economy of steam-power plants in which the use of superheated steam is a factor which cannot be disregarded. For one thing, the introduction of the steam turbine has emphasized more than ever before the advantages to be gained by the use of superheated steam, as it has been shown that the reduction in steam consumption of turbines due to the use of superheated steam is very materially greater than the reduction in the steam consumption of reciprocating engines due to the same cause, at least in land installations, and there is no reason why the same should not hold true in marine work. According to data collected by Mr. R. M. Neilson, which is quoted elsewhere in this issue by Mr. F. J. Rowan in his resumé of superheated steam as applied to marine work, the increased economy of the turbine over the reciprocat-

ing engine due to the use of superheated steam is apparent at both low and high degrees of superheat, the percentage reduction of steam consumption per degree Fahrenheit ranging all the way from 0.47 at 13 degrees to 0.09 at 260 degrees in the case of the turbine, and from 0.25 at 31 degrees to 0.07 at 440 degrees in the case of the reciprocating engine. In general, it is claimed that the steam consumption of the turbine may be reduced 1 percent for each 10 degrees F. of superheat. Designers cannot well afford to disregard claims such as this when considering the installation of turbines as prime movers.

Many years ago Rankin summed up the advantages of using superheated steam as follows: an increase in the efficiency of the motive fluid without producing a dangerous pressure; a diminution of the density of the steam and consequent lessening of the back pressure, and a reduction of cylinder condensation and leakage. It is now pretty generally understood that practically the whole benefit derived from superheating is due to the latter cause. The thermodynamic advantage is comparatively small. The real advantage gained by superheating can only be determined by taking into consideration the performance of the entire plant, including the boiler, superheater, steam piping, valves and engine. An added consideration involved in marine installations is the question of weight and space occupied by the superheating apparatus. This is a matter of little importance on shore, but on board ship it cannot be neglected. Closely associated with this is the question of the effect of superheated steam on the design of the engine, piping and valves, and also on the liability of breakdowns and the increased cost of repairs to the machinery and the cost of the maintenance of the superheater itself. As regards the real advantage to be gained by the use of superheated steam in marine work, most results which have been published, where there is an opportunity to compare the performance of the same plant with and without the superheater, seem to show that an average saving of about 15 percent in coal consumption can be obtained by superheating. This is, of course, a very general statement, as the results in any particular case may vary widely from this, depending upon local conditions. This gain in coal consumption is apparently not obtained at the expense of any great increase in the cost of repairs or maintenance of machinery, for progress in the improvement of the materials and of the design of engines, valves, piping, etc., and in the construction of the superheater itself, has kept pace fully with the increased demand for apparatus to successfully withstand the high temperatures involved by the use of superheated steam. In the earlier days of superheated steam troubles with superheater tubes and troubles with rubbing surfaces of cylinders, piston rods, valves and packings frequently led engineers to abandon superheated steam for the many less troublesome means at their disposal for improving the capacity and economy of their steam plants. Now, however, since most of the refinements which were then available in other directions have become matters of standard practice, it is impossible to ignore the advantages of superheat, as far as the economy of a marine steam plant is concerned. That superheaters are now being considered as a necessity in a great many cases is shown by the fact that in America alone no less than twenty vessels, aggregating 158,450 horsepower, are so equipped, eight of which are naval vessels.

Progress has been made not only in the design of superheating apparatus and in the adaptation of engines to the use of superheated steam, but also in the investigation of the properties of superheated steam. For a great many years Regnault's figure of 0.48 was relied upon as the correct mean value of the specific heat of the steam; but recent investigations carried out in Germany by Knoblauch and Jacob and in America by Drs. Thomas, Heck and others, have shown that there is a considerable variation in the specific heat with different conditions of pressure and temperature. In general, the value of the specific heat decreases for any pressure as the temperature rises and increases for any given temperature as the pressure rises. Results obtained by Dr. Thomas, in America, and by Mollier, in Germany, agree substantially with those obtained by Knoblauch and Jacob. Furthermore, recent experiments by Dr. Harvey N. Davis, of Cambridge, Mass., have shown that Regnault's classic formula, which for sixty-one years has been used for the total heat of saturated steam, is not correct. Recomputed values of the specific heat of saturated steam differ from former standards by 3 percent at 32 degrees and by about 1 percent in the opposite direction at 275 degrees. Below 212 degrees there is an abundance of modern data to show that Regnault's formula runs high, the error reaching 18 B. T. U. at 32 degrees. Calculations based on the old values as established by Regnault are not entirely worthless, but now that more accurate values are at hand all computations of importance should be based on the new values.

At the present time there are not many different types of superheaters on the market, seven or eight different designs covering the entire field. It has been generally understood that the use of watertube boilers gave the superheater a decided impetus, because the superheater could be more easily applied to that type of boiler. Such is not really the case, however, for most of the superheaters can be applied to cylindrical boilers of the Scotch type. In general, it has been found an advantage to have the superheater so constructed that it could be cut off from the path of the hot gases if desired. Independently-fired superheaters have been used on board ship to some extent, although their use is more recent than the other types, the earliest types of superheaters usually being fitted in the uptakes or at the base of the funnels.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		May 1.	June 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons.........	90.0	92.3
Michigan ...	16,000	18½	New York Shipbuilding Co..	97.4	98.1
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	77.9	82.4
North Dakota	20,000	21	Fore River Shipbuilding Co..	81.5	84.8
Florida	20,000	20¾	Navy Yard, New York......	11.9	16.4
Utah	20,000	20¾	New York Shipbuilding Co...	14.9	20.0
TORPEDO-BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons........	81.6	88.4
Lamson	700	28	Wm. Cramp & Sons........	75.7	80.5
Preston	700	28	New York Shipbuilding Co..	70.7	77.4
Flusser	700	28	Bath Iron Works...........	68.7	74.0
Reid	700	28	Bath Iron Works...........	67.8	73.0
Paulding ...	742	29½	Bath Iron Works...........	9.8	14.2
Drayton	742	29½	Bath Iron Works...........	9.7	14.2
Roe	742	29½	Newp't News Shipbuilding Co.	38.6	46.7
Terry	742	29½	Newp't News Shipbuilding Co.	33.7	41.0
Perkins	742	29½	Fore River Shipbuilding Co..	22.0	28.3
Sterrett	742	29½	Fore River Shipbuilding Co..	22.0	28.3
McCall	742	29½	New York Shipbuilding Co..	11.7	13.1
Burrows	742	29½	New York Shipbuilding Co..	11.3	12.8
Warrington..	742	29½	Wm. Cramp & Sons........	16.0	19.6
Mayrant	742	29½	Wm. Cramp & Sons.........	16.1	23.4
SUBMARINE TORPEDO BOATS.					
Stingray	...	..	Fore River Shipbuilding Co..	89.8	91.7
Tarpon	...	..	Fore River Shipbuilding Co..	89.7	91.7
Bonita	...	..	Fore River Shipbuilding Co..	81.4	85.2
Snapper	...	..	Fore River Shipbuilding Co..	80.4	84.9
Narwhal ...	...	..	Fore River Shipbuilding Co..	89.7	91.6
Grayling ...	...	..	Fore River Shipbuilding Co..	84.6	88.8
Salmon	...	..	Fore River Shipbuilding Co..	75.3	81.0
Seal	...	..	Newp't News Shipbuilding Co.	12.7	18.0

TECHNICAL PUBLICATIONS.

Directory of Shipowners, Shipbuilders and Marine Engineers, 1909. Size, 6 by 8½ inches. Pages, 749. London: The Directory Publishing Company, Ltd., 3 Ludgate Circus Building, E. C. Price, 10/ ($2.50).

This important directory has reached its seventh year of publication and fully justifies its existence; in fact, it seems indispensable to all who would be fully acquainted with the personnel of the shipowning, building and marine engineering world. All the shipping companies are detailed, with particulars as to their boats; to facilitate reference there is a copious index, and the owner and details of any particular vessel can be easily found. The leading officials of the various firms of shipbuilders and marine engineers are given, together with the number of berths, maximum output, capacity, and the size of the drydocks. Besides the "Boat Index," already indicated, there is a "Personal Index."

Machine Drawing and Design for Beginners. By Henry J. Spooner, C. E. Size, 9 by 6¾ inches. Pages, 266. Illustrations, 751. London, 1908: Longmans, Green & Company. Price, $1.25.

The author of this book has had extended experience in teaching the subjects of mechanical drawing and machine design, and has endeavored to present the subject in this book in such a way that the student may learn the rudiments of the subject without the aid of outside instruction. For this purpose the first six chapters are devoted entirely to the subject of drawing, the simplest details being carefully described and illustrated. It is intended that these chapters shall give the student sufficient instruction to enable him to learn the art of making working drawings of simple pieces. The remaining chapters treat more particularly of matters relating to details of machine parts. Not only is the correct method of making working drawings of the details explained, but the calculations for proportioning the various parts are also given, so that it is not necessary for the student to refer to a handbook or other source of information for his data. The details described are very practical, including such pieces of machinery as shafting, cranks, journals, couplings, clutches, keys, bolts, nuts, screws, roller and ball bearings, toothed gearing, pistons and cylinders, crossheads and guides, connecting rods, etc. One chapter is devoted to riveted joints, in which not only the proportions of different kinds of rivets are given, but the computations for various styles of riveted joints, and the method of figuring strength is also described. The text is concise and clear, and the book is profusely illustrated, so that it cannot fail to be of value to the student in this branch of engineering.

Steam Turbines. (Power Handbook Series), by Hubert E. Collins. Size, 4½ by 6¾ inches. Pages, 186. Figures, 76. New York, 1909. Hill Publishing Company. Price $1.00.

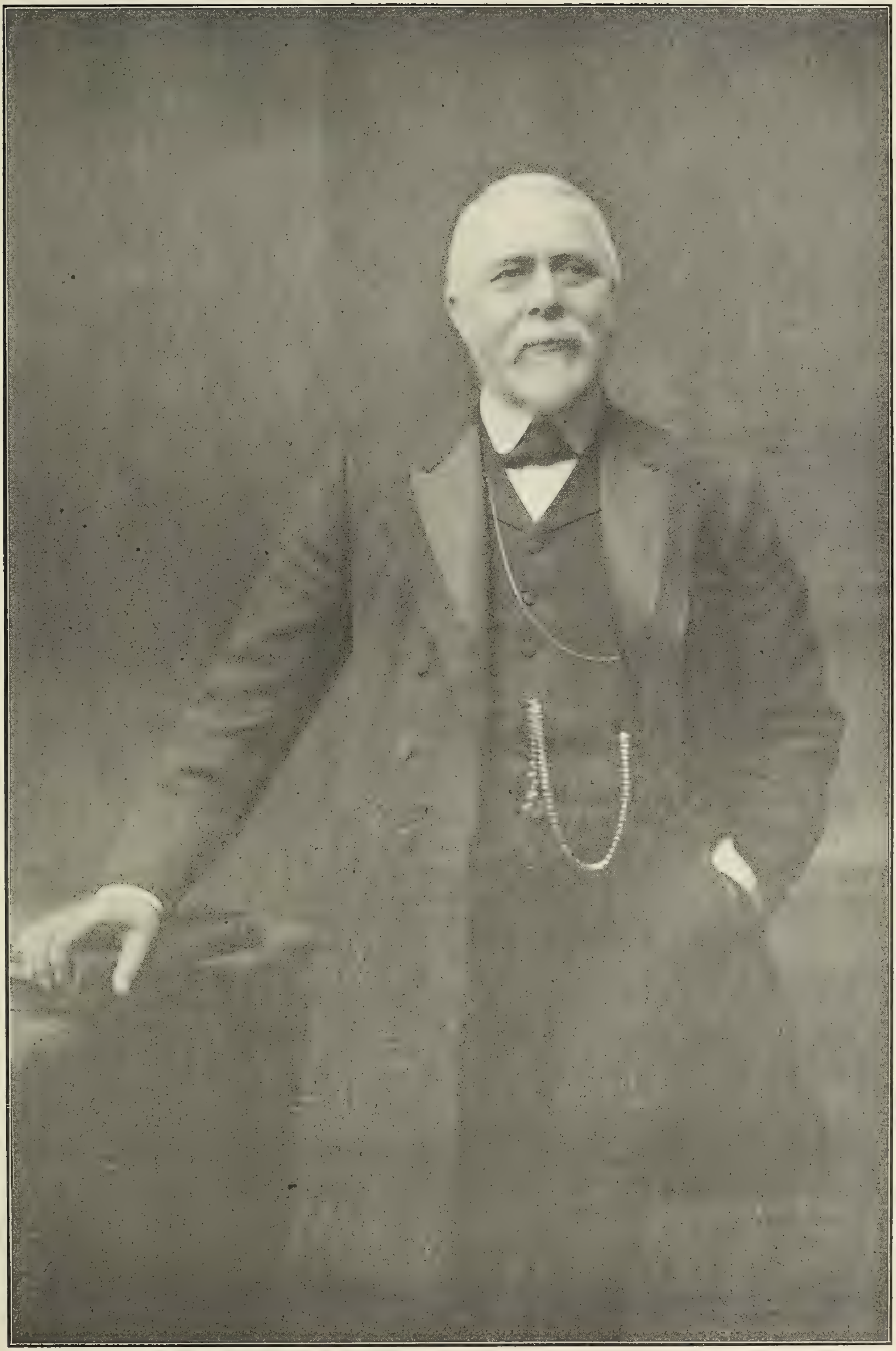
The large number of steam turbines now being installed in power plants necessitates the acquisition of a certain amount of practical knowledge regarding turbines by the engineer in charge of the plant in order that he may operate the plant successfully. This book attempts to give a compact manual for engineers who are in charge of turbine plants. The principal standard types of turbines are carefully described and following this are chapters on the proper methods of testing a steam turbine, auxiliaries for steam turbines and troubles with steam turbine auxiliaries.

SIR WILLIAM HENRY WHITE.

Probably there is no more eminent living authority on the subjects of naval architecture and marine engineering than Sir William Henry White, K. C. B., F. R. S., LL. D., D. Sc., formerly chief constructor of the British Admiralty. He first became connected with the Admiralty in 1867, and remained in the constructive department until 1883, rising meanwhile to the rank of chief constructor. From 1870 to 1881 he was also professor of naval architecture at the Royal School of Architecture and Royal Naval College. When, in 1883, Armstrong & Company, of Newcastle, established a department for the building of warships, Sir William White organized and directed the department. This work occupied him until 1885, when he became director of naval construction and the assistant controller of the Royal Navy. This position he held until February, 1902, and, during that period, he was responsible for the design of all His Majesty's warships. He was finally forced to resign on account of ill health, and was awarded a special grant of money by vote of Parliament in recognition of his exceptional services to the navy.

Such, in brief, is the professional record of this distinguished constructor. That his time has not been devoted entirely to the pursuit of one single branch of science is evident from the interest which he took in almost every important engineering organization, not only in Great Britain, but, as well, in the United States and other countries. He is a past president of the Institution of Civil Engineers and of the Institution of Mechanical Engineers, a vice-president of the Institution of Naval Architects and past president of the Institutions of Marine Engineers and Junior Engineers. He is also past master of the Shipwrights Company of London; a foreign member of the Royal Academy of Sciences of Sweden; and an honorary member of the Association Technique Maritime, the American Societies of Civil Engineers, Mechanical Engineers and Naval Architects; and an honorary member of the Institution of Engineers and Shipbuilders in Scotland; of the Northeast Coast Institution of Shipbuilders and Engineers, and chairman of the Board of Studies in mechanical engineering at the London University.

Numerous professional papers have been presented by him before these various societies, and he has contributed much in the way of valuable discussion on subjects presented by other members. He is the author of a "Manual of Naval Architecture," and also a frequent contributor to the technical and engineering press.

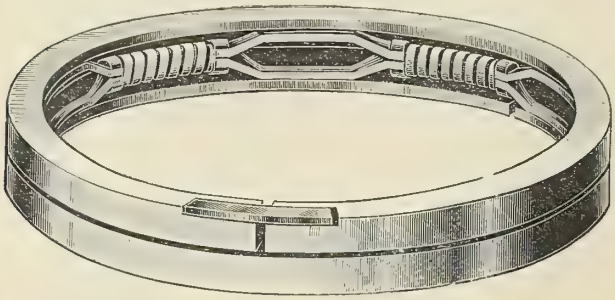


SIR WILLIAM HENRY WHITE, K. C. B., F. R. S., LL. D., D. SC.

ENGINEERING SPECIALTIES.

Standard Piston Rings.

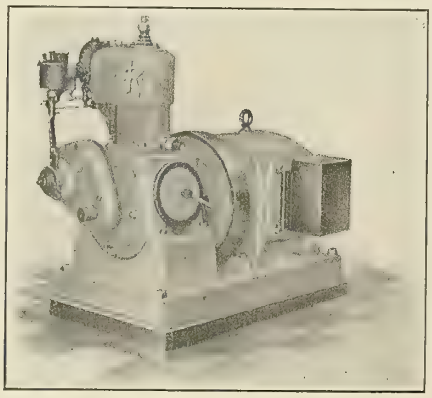
The piston rings manufactured by the Standard Piston Ring & Engineering Company, Limited, Premier Works, Don Road, Sheffield, are so constructed that the spring combines the necessary vertical and lateral actions in such a way that the rings can be worked at the highest speeds and pressures commonly used. This is due particularly to the fact that a maximum amount of vertical pressure is obtained against the piston flanges. The inner surface of the piston ring is coned to afford a snug bed for the oval springs when in compression. As shown in the illustration, these springs lie immediately under the face of the ring in contact with the cylinder. They



have liberal bearing surface, so they do not form grooves in the piston rings, yet they may be accurately adjusted by a thin washer placed over the shanks of the long springs. The packing rings themselves are made from a special brand of iron manufactured exclusively for piston rings. It is claimed that it is tough and very close-grained, and possesses good enduring qualities. Tests are quoted by the manufacturers, showing that one of these rings of the Ramsbottom type, 3¼ inches in diameter, and having an opening of ⅛ inch, was sprung open until the opening was 1⅛ inches, the extension being, therefore, 1 inch. This was again tried, the width of the opening being extended ⅛ inch at a time until it reached 1½ inches.

The Reavell Vertical Paraffin (Kerosene) Oil Engine.

The Reavell paraffin oil engine is of the vertical "four stroke" type, having one power stroke in every two revolutions. The cylinder of the engine is directly bolted to the standard, and the main bearings are spigotted into an accurately bored recess on either side, thus ensuring good alinement. The half-time shaft works in bushes also fixed in the standard, the cams being made solid with the shaft. Both inlet and exhaust valves are mechanically operated from this



shaft and are of ample area. A special arrangement is provided to prevent any but a vertical thrust being exerted on the tappet rods. This consists of levers carrying rollers, having their fulcrum at the side opposite to the cam shaft, thus obviating undue wear on the bushes which guide the tappet rods. The governor is of the horizontal centrifugal type directly attached to the shaft and is arranged on the end of the half-time shaft, being connected by means of suitable levers to a butterfly valve fixed in the vapor-inlet pipe. Governing is effected by throttling the supply of vapor. The commutator is of standard design, consisting of a spring-loaded roller pressing over a metal segment. The position of the commutator can of course be set so as to give the most efficient results for igniting the charge. The engine is water-cooled and can be arranged either with a thermo-syphon tank, circulating pump, or any other convenient method. The manufacturers are Reavell & Company, Limited, Ipswich.

A Few New Starrett Tools.

The illustrations show a number of new tools recently placed on the market by the L. S. Starrett Company, Athol, Mass. Fig. 1 is a universal bevel protractor constructed with verniers reading to five minutes or one-twelfth of a degree. The verniers are so placed with relation to the graduated half-circle as to make the protractor readable by vernier in any

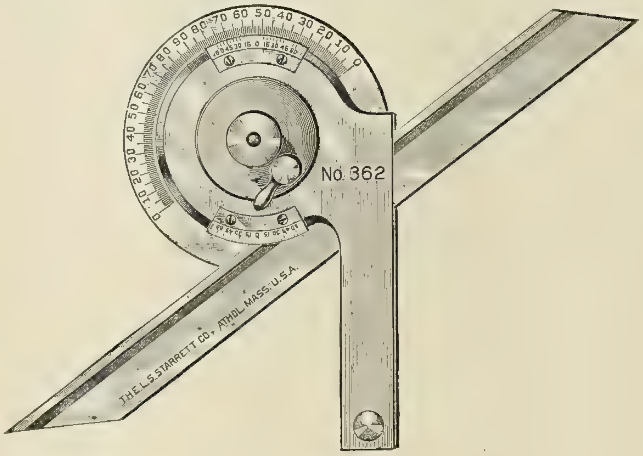


FIG. 1.

position. The disk is graded in degrees from zero to 90 each way and rotates the entire circle on a central stud inside the case. The blade clamped by an eccentric stud against the edge of the disk may be slipped back and forth its full length, or turned at any angle around the circle and firmly clamped at any point. An important feature of the tool is the fact that

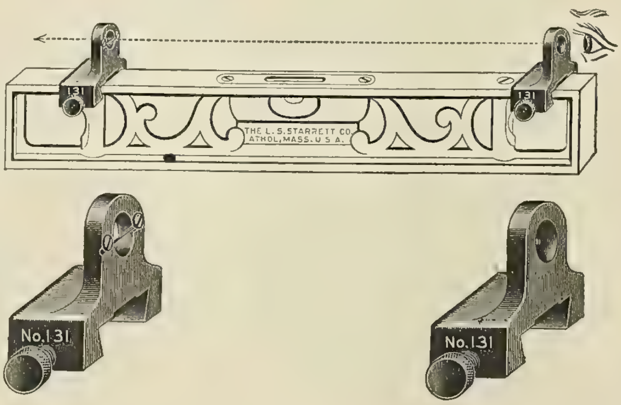


FIG. 2.

the figures on the vernier are placed close to the holes, thus making it easy to read the tool when taking measurements. The central lock nut may be given a slight turn when the protractor is firmly held in position. The protractor stock is 4 inches long and has either a 7 or a 12-inch blade ½ inch wide; with the 7-inch blade the tool weighs only 6 ounces.

Fig. 2 shows attachments made to slip on and off the top side of the Starrett Company's iron levels to be used for sighting. The attachments are held in place by set screws and are provided with sight holes, one with a cross wire, enabling the workman to line accurately from the top of and parallel with the level. Sighting through the holes will enable one to use the common level for leveling a plot of ground from a fixed point at long range. These sights are made in sizes corresponding with various sizes of levels.

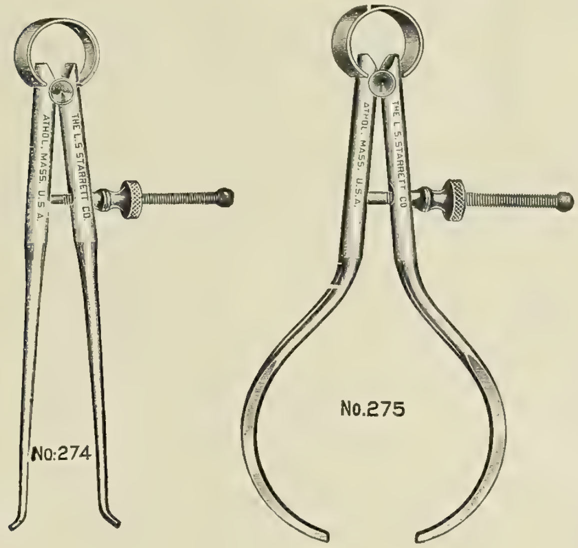


FIG. 3.

Fig. 3 shows two styles of tool makers' calipers. These are made from round stock with the legs drawn down, making them stiff and hard. The fulcrum stud is hardened and the screw and nut are carefully fitted. These tools are made in sizes from 2 to 6 inches.

Robinson's Rotary Cutters and Suction Apparatus.

Editor INTERNATIONAL MARINE ENGINEERING:

I am interested to note that three of the dredges illustrated in your May number are from my designs, namely: The 8-yard dipper dredge for the Cuban Government, the hydraulic dredge *Alexandra,* built by Simons & Company, and the two large dredges *Jinga* and *Kalu,* for Bombay, also built by Simons. These three dredges built by Simons are fitted with my improved dredging apparatus, including rotary cutter, suction frame and driving gear, for which the details were furnished from this office, and the remainder of the ship details, etc., being furnished by Simons. In your article describing the *Alexandra* I observe you give me credit for Robinson's rotary cutter, but in the article describing the *Jinga* and *Kalu* there is no credit given. I may say that since your article was written these two dredges for Bombay have completed their three months' guarantee, and having fulfilled the requirements have been accepted by the Bombay Trust. The work done at times exceeded 3,000 yards per hour pumped a distance of 4,000 feet.

MONTREAL, CAN. A. W. ROBINSON.

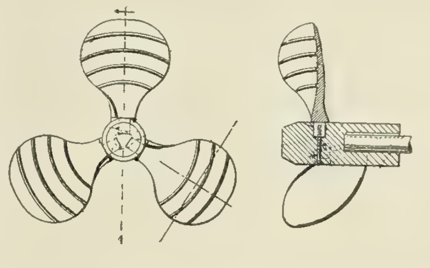
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

914,857. PROPELLER. MORGAN B. MILLER, OF SAN JOSE, CAL., ASSIGNOR OF ONE-HALF TO GEORGE W. HARVEY, OF SAN JOSE.

Claim 1.—A propeller blade having a dished engaging face, the curvature thereof being on arcs of circles and having a greater radius



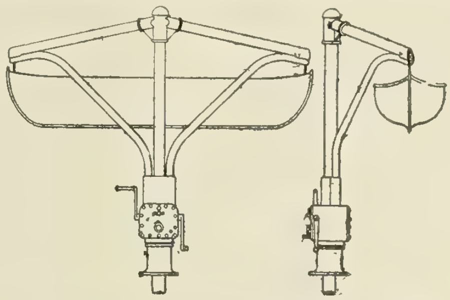
in a direction transverse from the propeller shaft than radially thereto. Four claims.

915,004. PNEUMATIC PROPULSION OF VESSELS. EDWARD WILDE, OF PHILADELPHIA, PA.

Claim 1.—In a means for the propulsion of vessels by pneumatic pressure, the combination of a vessel having a keel, of a guard at each side of the keel, and for a portion of its length, and below the hull; spaces formed between the guards and the keel which are open to the circulation of water at the bottom and at each end, and compressors having means to deliver pneumatic pressure to said spaces, toward the bow and toward the stern of the vessel. Eight claims.

915,118. BOAT DAVIT. PERCY G. SANBORN, OF SAN FRANCISCO, AND WALTER A. HESSE, OF ALAMEDA, CAL.

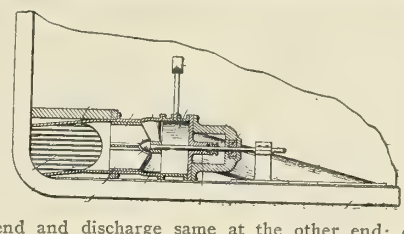
Claim 1.—In combination with a stand or base, a casing rotatable on said base, means for rotating the same thereon, a post secured upon said casing and having diverging arms arranged to guide ropes for



supporting a boat, drums in said casing on which said ropes can be wound, high and low-speed mechanisms for rotating said drums, and means for selectively operating said mechanisms. Eleven claims.

915,255. SCREW PROPELLER. ALBERT RICHARD WEISZ, OF BROOKLYN, N. Y., ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO WEISZ ROTARY PISTON AND ATMOSPHERIC MOTOR COMPANY, A CORPORATION OF NEW YORK.

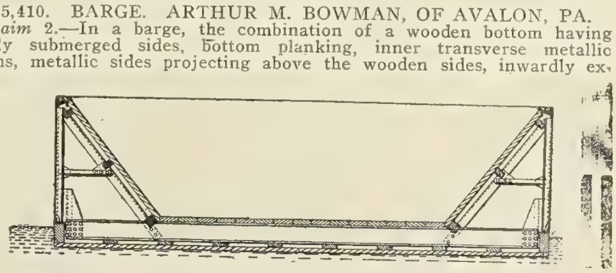
Claim 1.—In a device, the combination with a tube adapted to conduct fluid, a propeller in said tube adapted to draw the fluid into said



tube at one end and discharge same at the other end; of means disposed in the suction side of said tube conforming snugly to the shape of said propeller for preventing a whirling motion of the fluid before it reaches said propeller. Two claims.

915,410. BARGE. ARTHUR M. BOWMAN, OF AVALON, PA.

Claim 2.—In a barge, the combination of a wooden bottom having partly submerged sides, bottom planking, inner transverse metallic beams, metallic sides projecting above the wooden sides, inwardly ex-



tending side-bracing elements connected with the metallic sides, upwardly rounded end plates, and intervening transverse partitions. Eight claims.

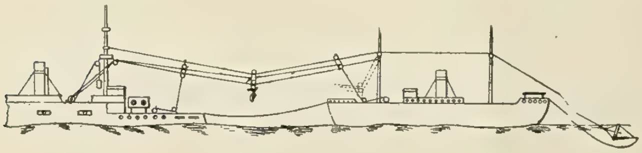
915,454. DREDGER HEAD. ROBERT A. LOWE, OF DULUTH, MINNESOTA, ASSIGNOR OF ONE-HALF TO W. H. LAMSON, OF HINCKLEY, MINN.

Claim 2.—A dredger head having an intake opening and a nozzle located on the wall of said head and arranged to project a jet against

the material contiguous to said opening and a material carrier arranged to deliver the material through said opening. Eighteen claims.

915,458. POWER TRANSMITTER AND CONTROLLER. THOMAS SPENCER MILLER, OF SOUTH ORANGE, N. J.

Claim 1.—In combination, a motor, two actuators by which its power is delivered, a driving connection between the motor and the first one



of said actuaries, a transmitter between the first and second of said actuators, a movable transmitter carrier and means whereby a uniform strain may be applied to said transmitter. Fifty-one claims.

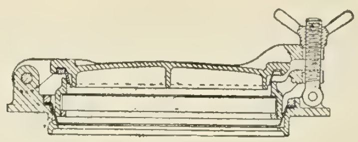
British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 4 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

23,024. SHIPS' BULKHEADS. W. M. HOSKINS, BORDESLEY, BIRMINGHAM.

Portable partitions, for use in ships for the purpose of dividing a space into cabins, are of such a length that they fit snugly between the stanchions. The edges are shaped to fit closely to the stanchions, and the rear sides are left open to permit the bulkheads to be placed in position. Open-topped cup brackets on a casting are adapted to receive the snugs on the fitting secured to the bulkhead. In order to secure privacy, a flange or closure plate is provided on the fitting, or attached to the bulkhead, completely covering one side of the bulkhead clearances. The cup brackets are provided with extensions or bearing pieces, against which the outer vertical edges of the closure plates are adapted to fit. The bulkhead fittings may also be provided with sockets to receive studs carried by folding berths, by which the berths may be supported.

23,244. SHIPS' SCUTTLES AND SIDE LIGHTS. F. G. P. PRESTON, OF STONE & CO., DEPTFORD, KENT, AND G. E. JAKEMAN, PECKHAM, SURREY.

A jointing device, for the scuttles and side lights of ships, consists of a ring of metal or other material having a certain amount of elasticity, comparatively thin, and mounted in the frame of the scuttle, so that the edge of the glass frame, which is made sharp, beaded, or of conical form, may contact with the surface of the ring and form a tight joint when pressed against it. The figure shows a form of the jointing ring of the shape of a frustrum, applied to both the glass frame and dead light. Instead of this form, the ring may be of either of several different forms; in one of which are two contacting rings arranged to



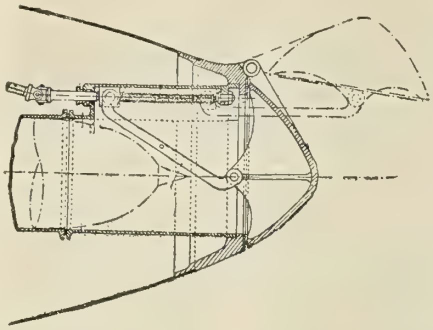
form a tight joint under pressure applied when closing the scuttle. Another form of the ring is of semi-circular cross-section, and is reinforced by a backing of rubber or other resilient material. When applied to frames which turn on trunnions through a right angle to admit air through the scuttle, the ring is bulged or curved in section. The jointing device is also described with reference to sliding scuttles and to scuttles closed by partial rotation in conjunction with wedge action.

23,530. LIFEBOATS. G. E. ENGLUND, LYSEKIL, SWEDEN.

In lifeboats of the class in which the boat proper is supported by an hermetically-closed spool-shaped floating body, the spool-shaped body is provided with a contracted central part, around which is rotatably mounted a drum, rigidly connected to the boat proper, and keel. To prevent excessive friction between the drum and the central part, anti-friction rings are provided, which are prevented from longitudinal movement by means of stop rings. Rollers or balls may be used instead of the rings. The boat may be provided with watertight compartments in its bottom and with oars or other propelling apparatus. The boat is independent of the rotary motion of the float, and capsizing is thus prevented.

23,518. TORPEDOES. P. M. JUSTICE, LONDON.

Ejecting Tubes.—The door is closed by means of a link and a screwed spindle and nut operated by a rod. A screwed nut on the rod is adapted to lock the firing lever when the door is closed. The lock bolt



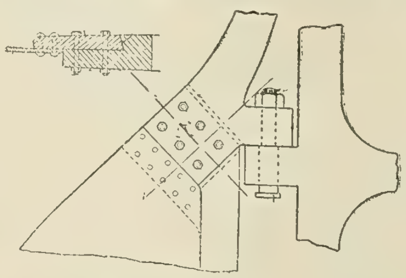
and the firing valve are operated by a common lever. A slot-and-pin connection is provided, so that the bolt may be removed before the valve is opened.

23,742. SHIPS' MASTS AND FUNNELS, LOWERING AND RAISING. H. CORDEN, NEW HOLLAND, LINCOLNSHIRE.

The invention is described as applied to ships' funnels, and is stated to be applicable to masts. The upper part of the funnel is pivoted in a spindle supported by the lower part of the funnel. The funnel is lowered by means of a wormwheel or toothed quadrant fixed on the spindle or on the disc attached to the spindle, and engaging with a worm on a spindle turned by means of a hand wheel. The spindle is mounted on bearings in a hollow casting or box carried by a bracket on the base of the funnel. The box may be pivoted on the bracket, and the bracket may have a radial slot in it for studs on the box to work in, so that the box and the spindle may be adjusted and set at any suitable angle. Means are employed for locking the funnel to the base part when the funnel is in its raised position, so as to take the weight of the funnel off the spindle. A link having side projections is carried by a bracket mounted on the funnel, and a bracket mounted on the bracket has two lugs, the faces of which are inclined, so that the bottom part of the link will ride up and drop behind them when the funnel is raised. On the bracket is rotatably mounted a conical body having round the base an enlargement, of spiral form and sharp at the commencement. The conical body is rotated by an arm, so that the underside of the spiral enlargement may pass over the bottom end of the link, securing the link. When the arm is turned in the opposite direction, the sharp end of the enlargement passes under the end of the link and lifts it clear of the projections. The arm is supported when in its raised position by a chain.

23,906. RUDDERS. R. S. BAGNALL & SONS AND A. F. FAIRBAIRN, SOUTH HYLTON FORGE, NEAR SUNDERLAND.

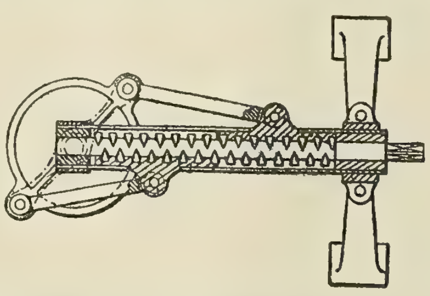
Relates to the connection of the rudder post to the rudder stock. The rudder post is connected to the rudder stock at an angle of about 45 degrees by half-lap joints, which are tied together by bolts. The meeting faces are inclined. The post is provided with an extension, to



which the rudder plate is riveted. The upper gudgeon is integral with the stock and is connected to the stern frame by a pintle, of which the head is placed sufficiently far beneath the under surface of the gudgeon to allow the stock to be raised to clear the dovetailed face between the laps, so that the rudder may be unshipped without removing the pintle.

28,259. STEERING SHIPS. H. JARMAN, LONDON.

Relates to screw steering gear for yachts, etc., of the type in which a divided nut with double screw action is employed to transmit the mo-



tion from the steering wheel to the rudderhead. The half-nuts are enclosed in a slotted supporting tube mounted at one end on the rudderhead and at the other on a fixed standard.

International Marine Engineering

AUGUST, 1909.

REINFORCED CONCRETE BOATS.

BY H. PRIME KIEFFER, C. E.

When it was first reported that in Italy boats were being successfully built of concrete, the idea was considered an innovation in shipbuilding. Upon investigating the manner in which these boats are built, however, it was found that the present method of construction is based upon ideas which were in practice hundreds of years ago in Egypt. The boats used by the ancient Egyptians on the Nile consisted of wicker frame work plastered over with clay. The concrete boats have absolutely no effect on the concrete, and that marine growths would not adhere to it, it was decided to build boats on a larger scale. Three pontoons, about 80 feet in length, 10 feet in width and 3 feet 6 inches in depth, were constructed, and launched on the Tiber, near Rome. In cross-section they were similar to a flat U, and were divided longitudinally into six equal compartments. They were held together by concrete trusses, and a large platform was placed over them.

FIG. 1.—TYPICAL 150-TON REINFORCED CONCRETE BARGE.

which are now coming into extensive use in Italy are built in very much the same way. Instead of reeds, however, the reinforcement to-day consists of steel rods, and cement is used instead of clay. Señor Carlo Gabellini, head of the firm, Societa Cemento Armato e Retino Gabellini, Rome, Italy, is the inventor of this process.

Some small rowboats were among the very first that were built. These were tested for rigidity and elasticity and then taken to the open sea, where they remained in salt water for some two years. After it was apparent that sea water would This simple construction has been utilized ever since as a floating construction dock for the new floats.

A very clever idea in connection with the design of this dock is that it is so arranged that when a new vessel is to be launched water is allowed to siphon into the first two or three forward compartments of each pontoon, thus lowering one end of the dock and allowing the new construction to glide gently off the ways. The water is then pumped from the filled compartments and the dock rises again.

In 1897 the company built for the Aniene Rowing Club, of

Rome, two pontoons similar to those described, 67 feet in length, and upon these pontoons was placed a concrete boat-house for the repair and storage of boats. The pontoons were linked together by concrete trusses, and according to reports the entire structure has never required any repairs, remaining in sound condition to the present day.

ing one bridge on the River Po, in Northern Italy, and many others of a similar design are in use in various parts of that country.

Experiments in installing motive power on these boats are now being made, and the Gabellini Company are confident that they will prove that this can readily be done.

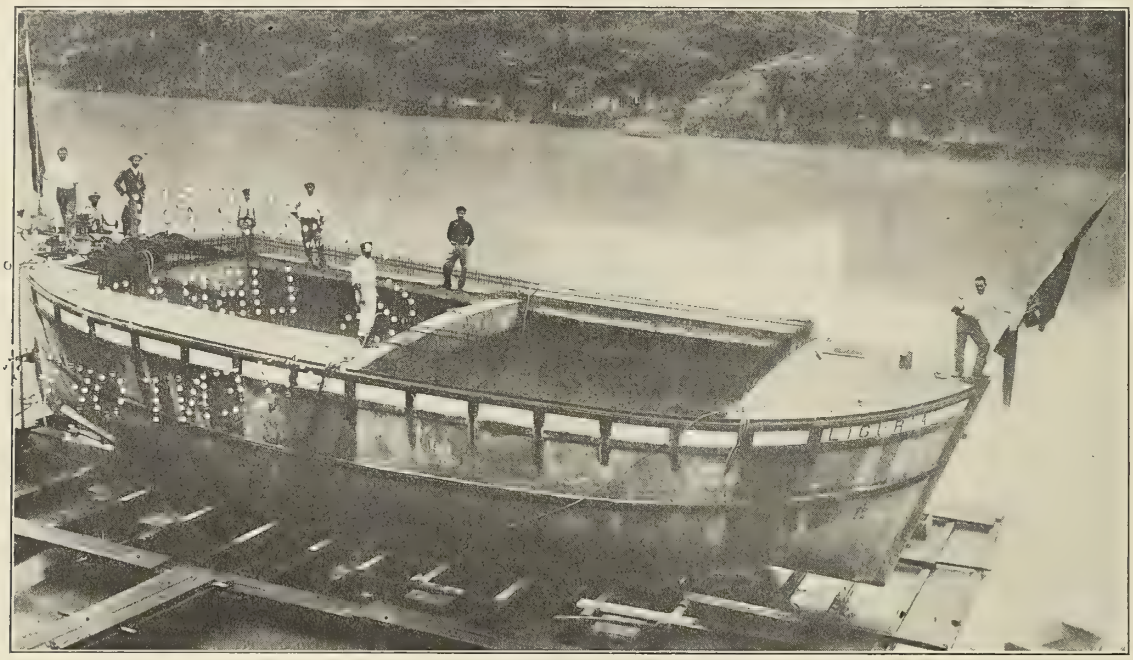


FIG. 2.—BARGE UNDER CONSTRUCTION, SHOWING REINFORCEMENT AND ATHWARTSHIP GIRDERS.

In 1905 the company built a 150-ton freight barge, for use in the military harbor of Spezzia, and in the following year they constructed one for the Italian Marine Service, which was taken to Spezzia, where it was subjected to severe tests by being drawn against a bridge pier and rammed by a powerful tugboat and various other trials. It was found so satisfactory, however, that four others of the same design were ordered, and they are now in use by the service. The dimensions of these barges are, roughly: Length, 60 feet; beam, 17

FIG. 3.—NO MACHINES, CRANES OR DERRICKS ARE NEEDED IN THE SHIPYARD.

feet, and inside depth from the cross girders, 5 feet. They have double sides and bottoms, with water-tight compartments at the ends, thus rendering them practically unsinkable. About this time, also, the company began the fabrication of a peculiarly shaped pontoon for supporting bridges on rivers. Twenty-four of these pontoons are now employed in support-

METHOD OF CONSTRUCTING A TYPICAL 150-TON BARGE.

The materials used in the boats, barges and pontoons built by the Gabellini Company consist of cement, sand, iron rods, both round and square, of various diameters, and both light and heavy networks of wires. Practically no skilled labor is employed on the actual construction work.

The keel of the barge is reinforced with eight square iron rods of 1-inch cross-section. These are not continuous, but are lapped over for a distance of 8 inches. They are bent to the exact longitudinal shape of the barge, and are held apart by smaller rods, carefully wired to the larger ones. After this there are next placed under these keel rods, and running at right angles to them, a number of other round rods, smaller in diameter and shaped to the various cross-sections of the barge. These are placed about every 3½ feet for the full length of the barge, and are held in place by small rods located near the top. Next, a system of longitudinal rods is placed, and the intersections of these with the cross rods are tied with wires. The general form of the barge is then complete.

Under these rods, and forming, as it were, a bottom to the boat, is next placed a network, or netting, of fine wires with a mesh of about ¼ inch. This netting is sufficiently wired to the rods to hold it in place. The concrete mixture is then applied to this surface, the wall being made about 1 inch in thickness. It is applied in the same way as plaster is placed on lath. After this is completed and a firm set has taken place, a similar but much thinner coat of concrete is given from the inside, but the wires with which the longitudinal and cross rods are wired are not covered up. There is thus formed one shell.

In making the second or double bottom for the barge, the following method is pursued: Separately molded concrete slabs, about 2 inches thick, 6 inches high, and varying in length, are placed upon the lines of the principal longitudinal

and cross rods. This is readily done, as the wires joining their intersections are left exposed, as above noted. These concrete slabs are thoroughly grouted to the concrete base upon which they rest by a good grout of neat cement. If one could now look at the construction from the center of it, he would see all around him a number of boxes with concrete sides and bottoms. It only remains now to place lids on these boxes, and the barge will be double-bottomed and sided.

This is done in the following manner: Over the tops of these boxes, or compartments, is laid a wire netting of fine mesh, and this netting is joined to the concrete slabs forming the compartments by wiring it to the reinforcement previously placed in these slabs. Upon this netting is then placed a light coat of cement, probably about ¼ inch in thickness. In this process care is taken to join this coat carefully to the concrete slabs upon which the netting rests. At this stage there is placed another netting of heavy wires on the wet concrete surface, and upon this is placed, in turn, another coat of concrete, making a total thickness of from 1 to 1½ inches. This coat, which forms the inside of the barge, is rubbed until it becomes smooth. No waterproofing is used on this concrete, as it has been found that the process of rubbing the surface makes it impermeable to water and foreign substances, as well as proof against marine organisms.

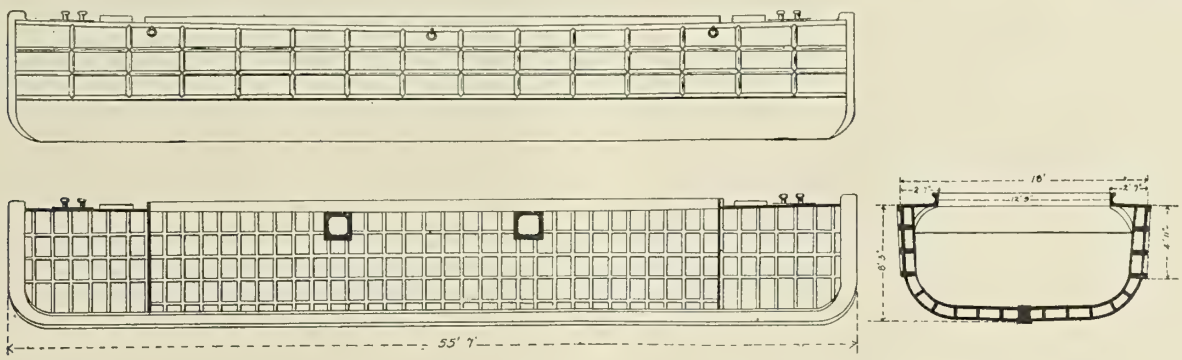


FIG. 4.—THE BARGES HAVE AN INNER AND OUTER SHELL, THE SPACE BETWEEN BEING SUBDIVIDED INTO SMALL WATERTIGHT COMPARTMENTS.

Each end of the barge is divided into two water-tight compartments, formed by two bulkheads extending from the keel to the deck of the boat. One bulkhead is placed transversely at a distance of 8 feet from the ends, and the other is placed on the center line of the boat. It must be clearly understood that the latter bulkhead does not extend throughout the length of the barge, but simply from the ends to the athwartship bulkheads. The compartments thus formed are not designed for holding goods to be transported, but are used for the storage of tools, ropes, canvas, etc., and for the protection of the main cargo in case of injury to the end compartments.

Two large square concrete beams, hollow, but heavily reinforced, extend athwartships at the top of the barge. The barge is not covered completely, but has a concrete overhang, which extends 2 feet 8 inches in from the side walls.

The keel, when completely concreted, is about 12 inches high and 6 inches thick. It is covered at the ends by a steel plate, ½ inch thick, and this plate extends slightly below the waterline.

ADVANTAGES OF CONCRETE FLOATING STRUCTURES.

Naval engineers well know the complications encountered in respect to individual constituent elements in designing and constructing flotation work and how indispensable for the purpose are establishments provided with a complete outfit of machinery, expert workmen and special materials. On the other hand, with the new system of concrete construction, any place near the water where the vessel is to be launched is well adapted for the work. The cement, sand, iron bars and netting are to be found in all markets, and can be easily transported to the place of fabrication. The sand, moreover, can frequently be found on the site.

FIG. 5.—PARTIAL INBOARD PROFILE AND MIDSHIP SECTION OF CAR FLOAT.

A primary advantage in these works is that, in case of a break at a point of the concrete walls which extends to the skeleton network, repairs can be effected by reuniting and also reinforcing the disconnected parts, and restoring them to their original form, if deformation has taken place. When the metallic parts are arranged a quick-setting cement is applied to the surface, as in the original work.

A water-borne structure built in this manner may be regarded as consisting of one piece, since it offers equal resistance at all points. The metallic network, which distributes over a large surface the effects of a blow or impact sustained at one point, not only diminishes the seriousness of damage due to collision but also confers upon the structure a considerable degree of elasticity, which permits it, after suffering momentarily a change of form, to return to its original state as soon as the strain caused by the external forces ceases to exist. This is a point about which engineers are skeptical, but it is claimed that experts and experience have proved its absolute correctness.

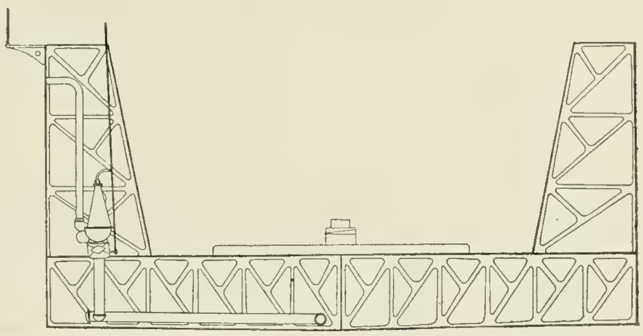


FIG. 6.—REINFORCED CONCRETE DRYDOCK, SHOWING METHOD OF BRACING.

There is little attrition in water. The external surface of the boat is brought to a grade of smoothness not attainable with wood or iron, and there is thus a saving in the force of propulsion. Since concrete exists best in water, and a century of ever-increasing use has shown it to be refractory to external agents, and since iron is protected from rust when embedded in cement to such an extent that after ten years no trace of rust has been found in samples of cement-covered bars, it may be safely stated that no trace of deterioration will be encountered in floating structures of reinforced concrete.

Incrustations, which in a short time destroy the smoothness of steel and wooden hulls and thus favor the life and growth

of animal and vegetable organisms, are entirely avoided in concrete construction. Thus, minimum resistance to speed is always preserved, and the expense of external cleaning and painting is avoided. In fact, cost of maintenance is practically eliminated, an advantage of great importance when it is considered that the annual repair bill for wood or steel hulls is very large compared with the first cost. Since concrete of the quality used in these vessels is non-absorbent, impermeable to humidity, and is not affected by ordinary chemical reactions, complaints of losses in cargoes caused by such agencies during transportation by water cease. Liquids can, of course, be carried in properly constructed vessels. No other material can be subjected to frequent washing and disinfection without danger of incurring loss of substance or absorption of moisture.

Comparing first cost and endurance in floating structures of wood and concrete, it has been found that a wooden barge requires, after five years' service, repairs entailing an expenditure of about 30 percent of the initial price, while similar structures of concrete are found after eight years of use to be in perfect condition.

BARGES FOR TRANSPORTING RAILROAD CARS.

At the present time the company is engaged in making a number of barges for the Italian State Railways, designed to carry six freight cars each. The barges will carry one line of tracks, will be single-bottomed (with one shell), and will set very low and flat in the water. The general design is shown in Fig. 5. They will be the longest floating structures built to date by the Gabellini Company, the length over all being about 158 feet.

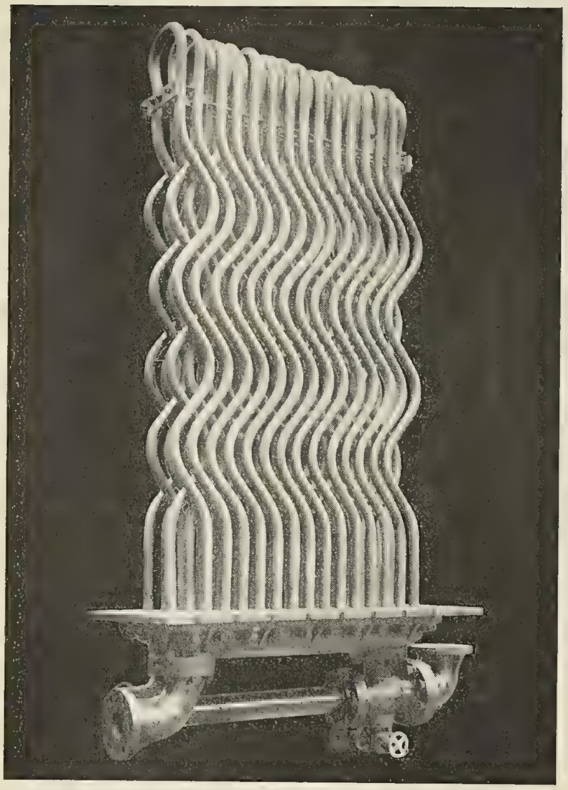


FIG. 10.—SUPERHEATER MANUFACTURED BY THE CENTRAL MARINE ENGINE WORKS.

SUPERHEATED STEAM IN MARINE WORK.—II.

BY F. J. ROWAN.

TYPES OF SUPERHEATERS USED IN RECENT MARINE WORK.

There are seven or eight different designs of superheaters known to be at work on board steamers fitted in Britain, Germany, America and France, and it is possible there may be one or two others of which the ship owners or their superintending engineers do not wish to publish particulars. Of those known, all but two seem to have been applied to cylindrical boilers, although all but one are capable of application to watertube designs also. The following are the superheater designs: (1) Those fitted by the Central Marine Engine Works; (2) those fitted by Mr. W. S. Hide in steamers under his care; (3) the Watkinson superheater; (4) the Babcock-Wilcox superheater; (5) the Dürr superheater; (6) the Schmidt superheater; (7) the Foster superheater; (8) the Pielock superheater.

Of these, the first three kinds have been fitted in the up-takes or at the base of the funnel of Scotch or other cylindrical boilers. The Dürr superheaters are practically integral parts of their watertube boilers; the Foster is used in a similar position in boilers on land, but has been applied as an independently-fired superheater at sea; the Schmidt design has also been arranged as an independently-fired variety, as well as placed in the smoke tubes of dry-back

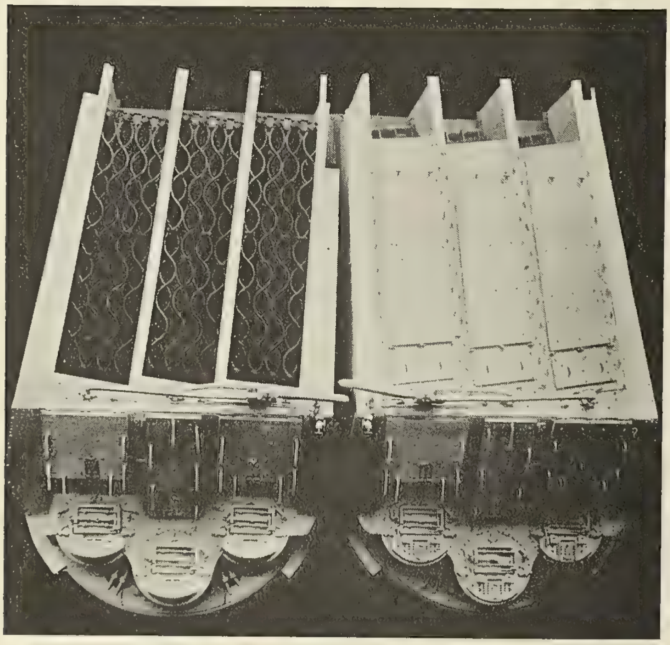


FIG. 9.

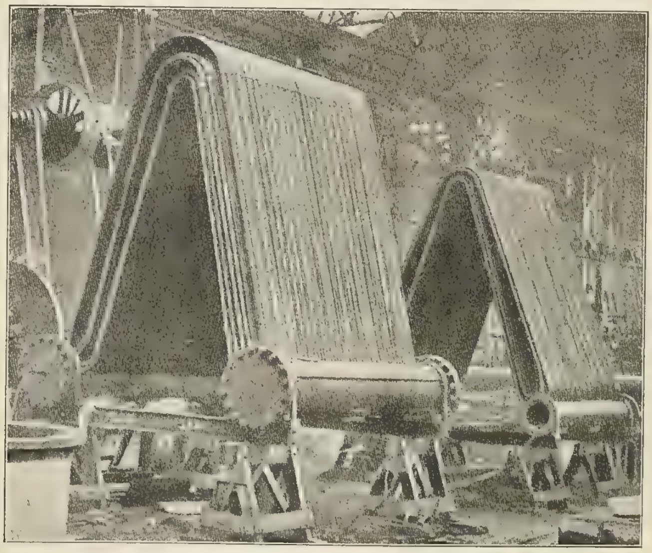


FIG. 11.—WATKINSON SUPERHEATERS.

boilers and in the flame tubes of cylindrical boilers specially designed, and the Pielock is a superheating chamber, forming an integral portion of the cylindrical Scotch boiler.

The superheater designed by the Central Marine Engine Works, of West Hartlepool, is composed of waved, or serpentine-shaped, tubes, either connected at top and bottom ends to cast iron headers, or bent to ∩ form with one set of

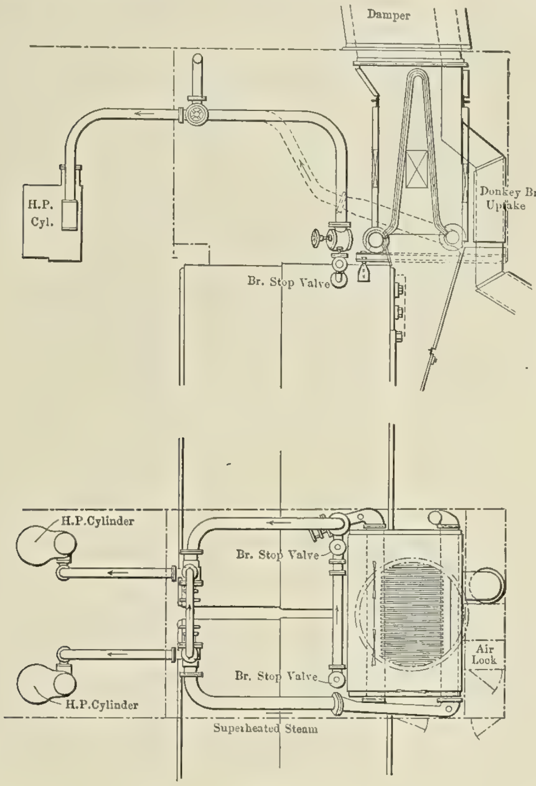


FIG. 12.

headers at the lower end. Figs. 9 and 10 illustrate both forms, Fig. 9 showing their position relatively to the boilers. The superheaters are fitted directly in the up-take, below the air-heating tubes, when forced draft on Howden's plan is employed, and just above the upper row of tubes in Scotch boilers. The superheaters installed by Mr. Hide are said to consist of a series of multiple U tubes with collectors at the inlet and outlet. No illustration of these is extant and the description is vague enough to be applicable to several designs. Some of the vessels equipped with Central Marine Engine Works superheaters are fitted with watertube boilers, but, as in those having scotch boilers, the superheaters are

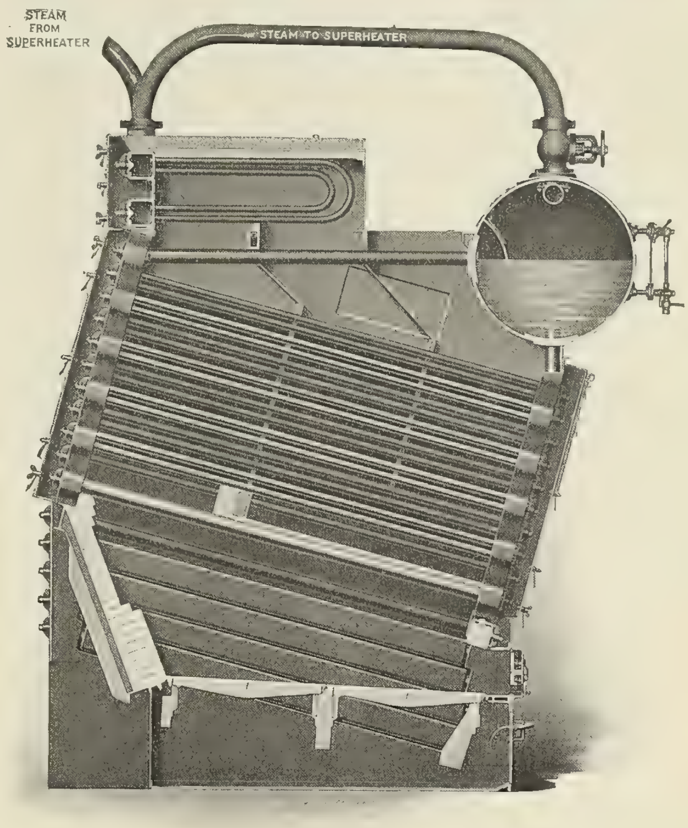


FIG. 14.—BABCOCK-WILCOX WATERTUBE BOILER WITH SUPERHEATER.

placed in the funnel and are heated by the waste gases.

The Watkinson superheater for marine use consists of multiple inverted U tubes, having their ends expanded into

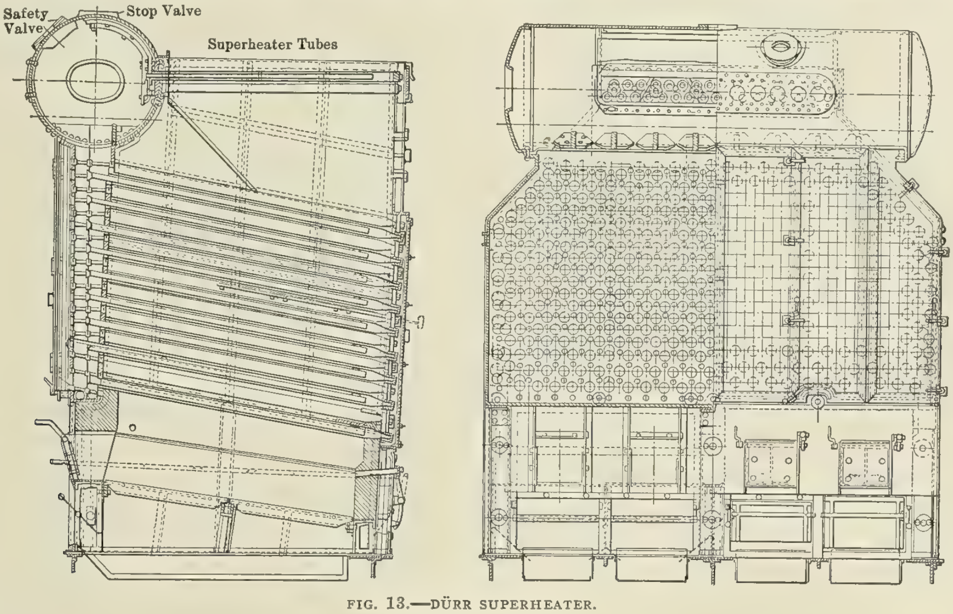


FIG. 13.—DÜRR SUPERHEATER.

cylindrical or pipe-shaped headers, as shown in Fig. 11. They are usually placed in the up-take, according to the arrangement shown in Fig. 12, but an independently-fired arrangement was fitted in one ship.

Fig. 14 illustrates the Babcock-Wilcox superheater as usually fitted with their marine type boiler, which is well

known. The superheater is of the multiple U tube variety—the tubes being placed horizontally in a position across and at right angles to the watertubes of the boiler—with the tube ends fastened into forged steel headers. As shown in this arrangement, the superheater is entirely separate from the boiler and is interposed in the path of the hot gases before they leave the boiler surfaces; the steam being conducted to the superheater from the main steam and water drum through independent pipes. Provision is also made for by-passing the superheater.

The Dürr superheater, illustrated in Fig. 13, is necessarily an integral part of the boiler to which it is attached, and cannot be altered in position with anything like the same freedom. It consists of rows of so-called "Field" or "Perkins" tubes (of which the Dürr watertube boiler is constructed) branching out from the steam space of the steam and water drum, the tubes being in the direct path of the hot gases immediately after leaving the boiler surfaces.

There are four types of the Schmidt marine superheater, viz.: the flame-tube superheater, for new boilers of the cylindrical type; the smoke-tube superheater, applicable to either old or new boilers; the funnel or smoke-box type of superheater, which can also be applied to existing or to new boilers, and an independently-fired superheater, suited for dealing with the steam from a group of boilers.

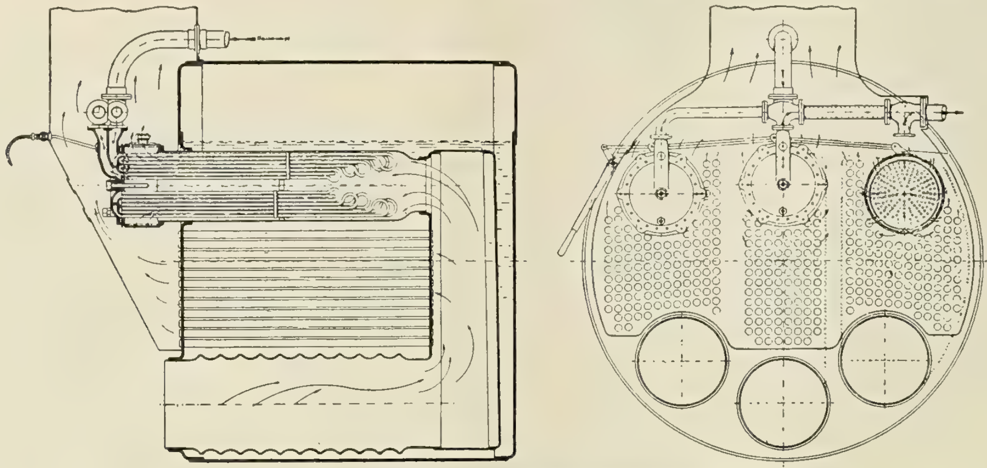


FIG. 15.—SCHMIDT FLAME TUBE SUPERHEATER.

The flame-tube superheater, illustrated in Fig. 15, is arranged in the form of one, two or three large tubes (according to the size of the boiler) located at the top of the tube plates. In these large tubes there are numerous small superheater tubes, looped and disposed radially as to their ends, which are expanded into the bottom plate of a ring-shaped header casting which projects into the up-take. The header is divided into several compartments, and the steam is made to pass to and fro in the small tubes connected with each compartment two or three times, passing into the compartments consecutively. The hot gases come in contact first with tubes containing the saturated steam from the boiler, and escape by openings in the header casting, which are controlled by a damper. A central steam pipe with nozzles is arranged for cleaning the superheater tube surfaces from soot and ash by steam jets.

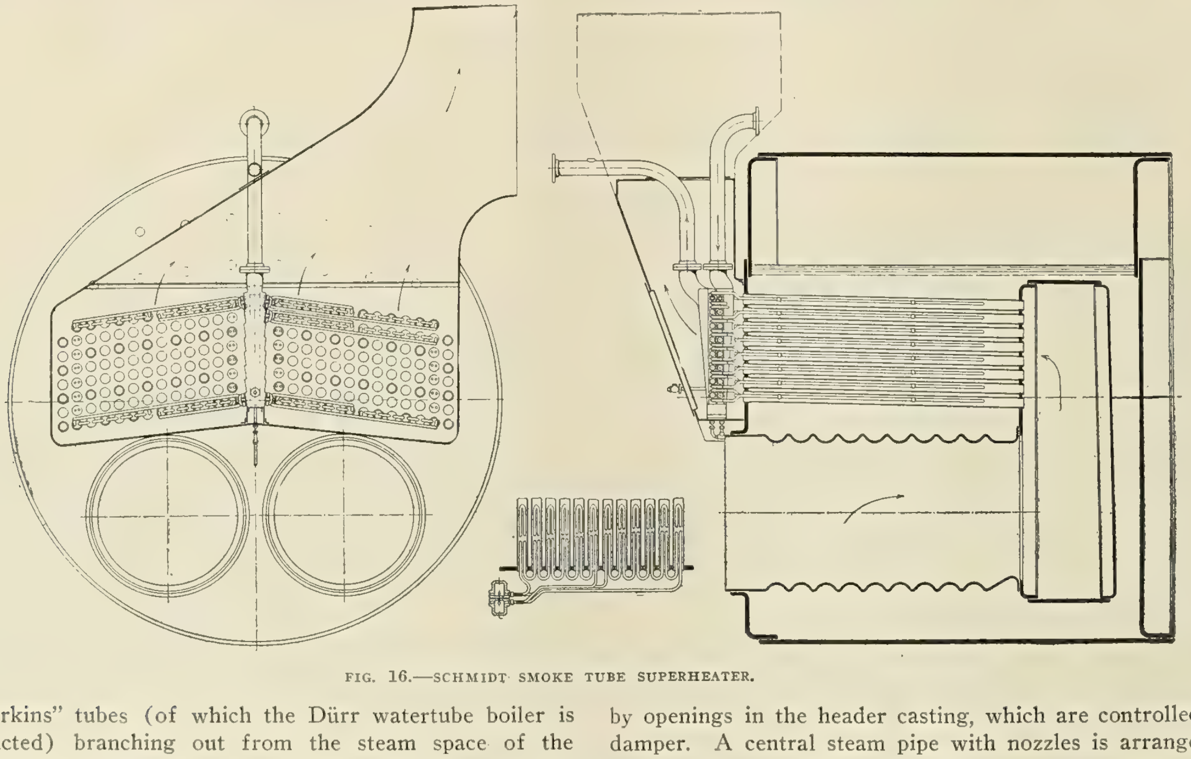


FIG. 16.—SCHMIDT SMOKE TUBE SUPERHEATER.

The smoke-tube superheater shown in Fig. 16 is applied to existing boilers where the tubes have an inside diameter of not less than 2¾ inches, the looped superheater pipes passing into these tubes and being grouped into horizontal or vertical headers. A steam jet or other blower is required in the

funnel to govern the draft in this case. Where boilers are new this kind of superheater is applied by substituting in the middle of the tube plates a group of tubes, of approximately 4 to 6 inches diameter, for the ordinary small tubes, and into these larger tubes the looped pipes are introduced. Within the smoke-box the superheater is separated from the other boiler tubes by means of a sheet iron casing.

The funnel and smoke-box arrangements are applied where the tubes of existing cylindrical boilers are too small in diameter to admit the looped superheater tubes. In the funnel arrangement a group of weldless steel pipes, of practically an inverted U form, stand vertically in an inner casing at the base of the funnel, their ends being expanded into a steam collector. The smoke-box form resembles the land type of

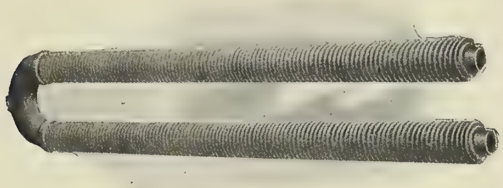


FIG. 17.—FOSTER SUPERHEATER ELEMENT.

Schmidt superheater, consisting of rows of horizontal U tubes built up inside a casing. In these two instances the hot gases from about a third of the boiler tubes are drawn rapidly through these tubes and the superheater, by this means furnishing hotter gases to the superheater than it would otherwise receive, but at the same time quickening the evaporation of that portion of the boiler.

The Schmidt independently-fired marine superheater is built up outside a small three-chambered watertube boiler, the watertubes and top drum of which shield the superheater tubes from too fierce a heat. There are four small drums,

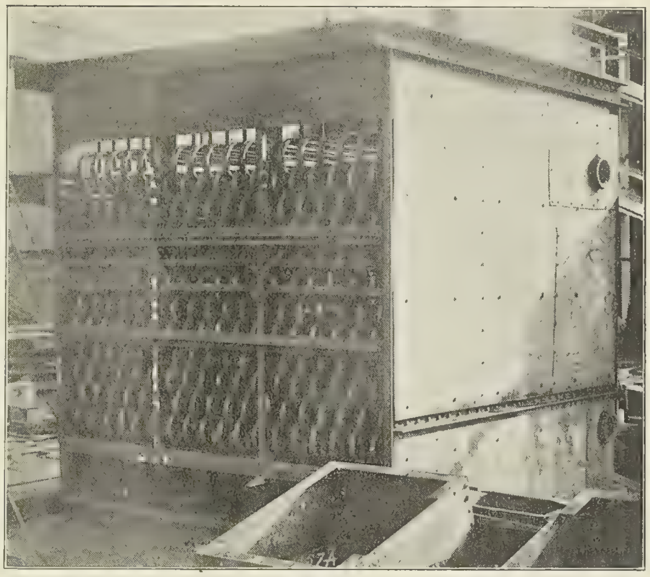


FIG. 19.—SEPARATELY-FIRED FOSTER SUPERHEATER ON S.S. BRAZOS.

divide the steam into thin films, compelling it to pass through the annular space thus formed. This will ensure a greater velocity of movement of the steam over the heating surface, and thus render that surface more efficient, and it is said to ensure greater uniformity of resulting steam temperature. The land form of Foster superheater also has discs of cast iron threaded on the superheater tubes (see Fig. 17), in order to prevent overheating of these in the independently-fired arrangement; but this feature has been discarded in the marine type so far. In the marine superheater shown in Fig. 19, the tubes are expanded into forged steel connecting and return headers, and the whole structure is enclosed in a steel

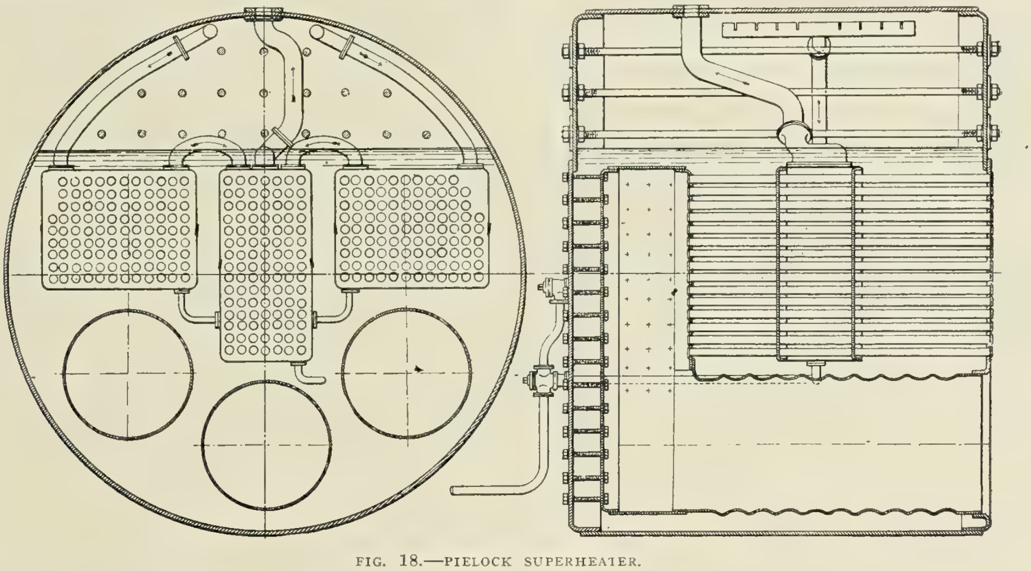


FIG. 18.—PIELOCK SUPERHEATER.

two directly above the central drum of the secondary boiler and one above each of its lower drums, and the small superheater tubes are so connected to these drums as to cause an efficient circulation of the steam over the surfaces exposed to the hot gases. The steam from the secondary boiler may be passed through the superheater or used for other purposes. This form is applied to a group of boilers.

The Foster superheater is formed of U tubes, or "hairpin-form" tubes, placed horizontally, but has the distinguishing feature that these tubes or elements are equipped with an inner tube of smaller diameter closed at both ends, so as to

casing having air spaces and non-conducting coverings. This casing practically forms the lower portion of the smokestack below the deck. It is carried on structural steel framework, attached to the deck beams and braced against pitching of the vessel.

The Pielock superheater, as will be seen from Fig. 18, forms an integral portion of Scotch cylindrical return-tube boilers. It consists of a central and two lateral steam superheating spaces, located over the three furnaces, and each surrounding about one-fourth of the boiler-tube lengths. The chambers are made watertight. The holes in the tube plates are 2.55 inches

diameter at one end of the tubes and 2.63 inches at the other end, to facilitate removal of the tubes. The saturated steam is taken from the top part of the steam space in the boiler; it flows to the two lateral chambers and thence to the central one, baffle plates diverting its flow round the tubes and to the steam pipe. In this case it will be seen that the steam surrounds the outsides of the smoke tubes through which the hot gases are passing, and the chambers are so placed that the gases have a length of tubes surrounded with water to pass through before reaching the superheater chamber.

(*To be continued.*)

A 6,000-TON FLOATING DRYDOCK.

BY WILLIAM T. DONNELLY.*

A new 6,000-ton pontoon floating drydock, which involves a number of new features in dock construction, has recently been completed by the writer for the John N. Robins Company, Erie Basin, Brooklyn, N. Y. The general dimensions of the dock, as constructed, are as follows: Length of wings, 334 feet 9 inches; length over all, 364 feet 9 inches; width over all, 100 feet; width between side walls, 76 feet; pontoons, 100 feet by 32 feet by 11 feet deep; height of wings, 30 feet above deck; lifting capacity, 6,500 tons; draft over keel blocks, 21 feet. As designed, the dock comprises eleven sections, with an outrigger at each end, giving a length over all of 425 feet. The lifting power of the extended dock of eleven sections will be slightly more than 7,000 tons.

The general requirements laid down covering the design of this dock stipulated that it should be the largest dock for which there was available room in the yard of the company; that it should be of the most advanced type, and such as could be built in the shortest possible time. At the time when the design of this dock was under discussion, there were in the yards of the John N. Robins Company three floating drydocks entirely of wood, two of which were more than fifty years old, and one forty-five years old. A careful and critical examination of these structures developed the fact that their timbers below the normal waterline were in perfectly sound condition. Samples of oak timber cut from one of them showed in laboratory tests strength equal to new wood. When it was further considered that one of these floating drydocks was of such a structure that it had never been removed from the water since being launched, the evidence was considered conclusive as to the desirability of wood for the under-water construction of floating drydocks. Examination of the upper works of these docks, made at the same time, equally demonstrated the undesirability of wood for the superstructure. Very much of the original superstructure had been from time to time replaced, and what remained was in a very unsatisfactory condition. The result was that the general plan for the new dock, as laid down, provided for wooden pontoons and steel wings. The general dimensions and proportions were arrived at from consideration of the structural weights and dimensions of the ships to be handled.

The dimensions and number of pontoons, which are correlated, were determined from consideration of the strength of the wings to be used, the controlling factor being that the pontoons were to be restricted to such size that the moments, due to the lifting power of any single pontoon, could be disregarded, thus making it possible to use the dock with any one pontoon disabled, either as to its buoyancy or through failure of its pumps.

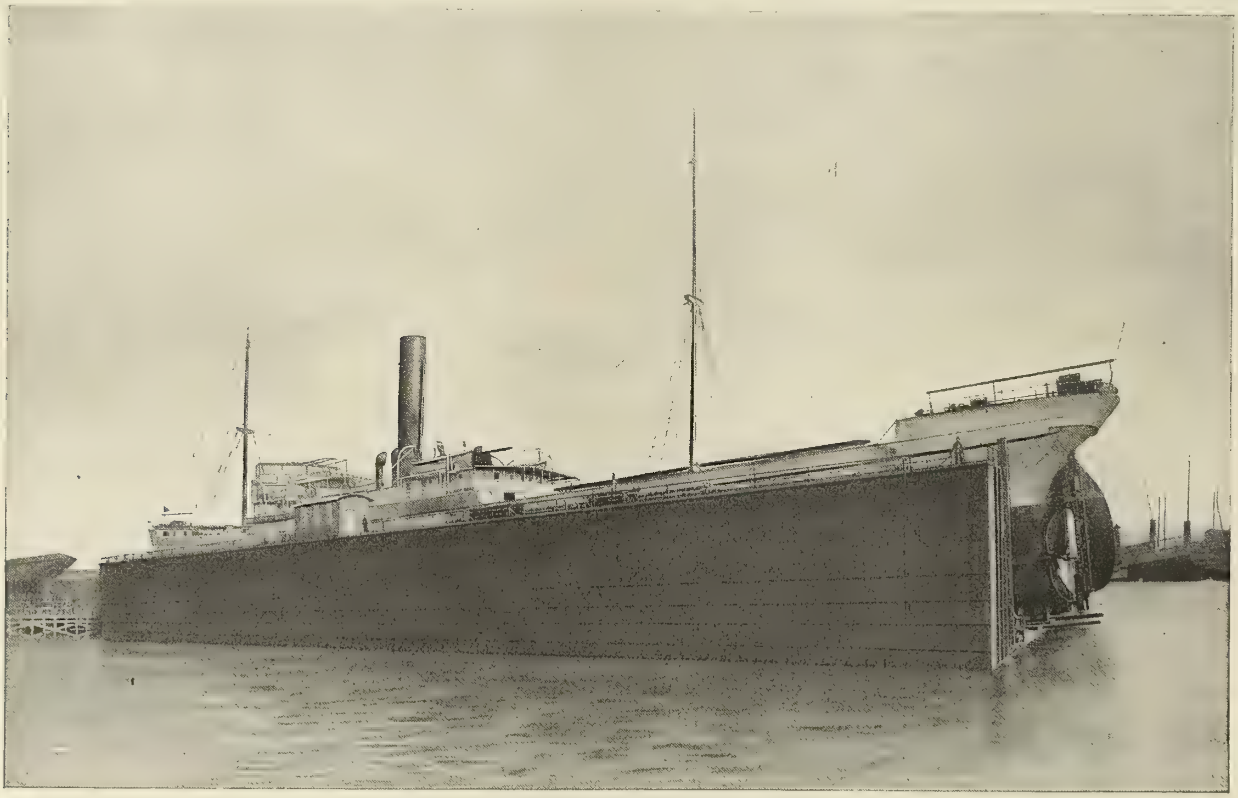


FIG. 1.—GENERAL VIEW OF 6,000-TON DRYDOCK.

CONNECTION OF WINGS AND PONTOONS.

One of the first considerations involved was the manner of securing together the wings and pontoons. Details of this are shown in Fig. 4. As the most familiar tools in the ship-repair yard are the driving maul and wedge, it was determined to so construct the attachment as to be operated by these familiar appliances. Around that part of the pontoon upon

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which the wing rests there was placed a packing timber 12 inches wide, carefully leveled up to meet fairly the bottom of the wing, and to the under-side of the wing, corresponding to this bearing, there was provided a ⅜ by 12-inch reinforcement of steel plate with carefully countersunk rivets. To form a water-joint between these surfaces there was provided a three-ply canvas packing treated with red lead. Corresponding to each frame on 3-foot centers, there was secured to the pontoons a steel casting with an eye, so constructed as to take a steel taper pin having a taper of ½ inch to the foot. A wrought iron link, about 12 inches long, connects this pin with a similar eye in a steel casting secured to the wing. The other pin was made without taper, but was provided with a flattened side, upon which shims could be laid to compensate for any practical difference in the length of the links. In this way it was found practicable to draw up all the fastenings and have all pins come fair.

PONTOONS.

All the pontoons are of identical construction, being 100 feet in length, corresponding to the width of the dock, 31 feet 10 inches in width and 11 feet deep. They each contain nine trusses on 3-foot centers, the design of the trusses being of the well-known form, comprising diagonals and a built-up arch member, each made very rigid by uprights secured to the side of the truss and blocking between the truss members. The design was so worked out as to have the bottom and deck planking both run in a direction parallel to the truss members, thus greatly adding to the strength of the completed structure. A center water-tight bulkhead, 10 inches thick, and three partial bulkheads on each side of the center, divide the pontoon into two water-tight compartments and six smaller compartments, giving great rigidity to the structure as a whole.

It will be noticed that that part of the deck of the pontoon upon which the wing rests is left open, and at the center of the pontoon, corresponding to the point upon which the keel of the vessel rests, 10 by 12-inch timbers are used as a continuous base for keel blocks. On each side of the center bulkhead, and on one side of each of the other bulkheads, tie rods are provided. These are made double, with saddles at top and bottom, the detailed construction of which is plainly shown in Fig. 5. The construction is such that the rods can be replaced at any time without disturbing any structural part of the dock. It will be further noticed that the tie rods are made double at the partial bulkheads, coinciding with the location of the inside of the wings, and extend through the deck of the pontoons, and serve to secure the cast steel shoe which takes a link and taper pin similar to the attachment on the outside of the wing.

STEEL WINGS.

The framing of the steel wings is on 3-foot centers, corresponding to the trusses in the pontoons. Each frame is cross-braced and stiffened by diagonals to resist the pressure of the water on the outside. The plating is varied in thickness, being ½ inch on the bottom, 7/16 inch on the lower sides, and reduced to 5/16 inch and ¼ inch near the top, the deck plating and top strake on the sides being ⅜ inch. Corners are reinforced by 6-inch by 6-inch by 7/16-inch angles.

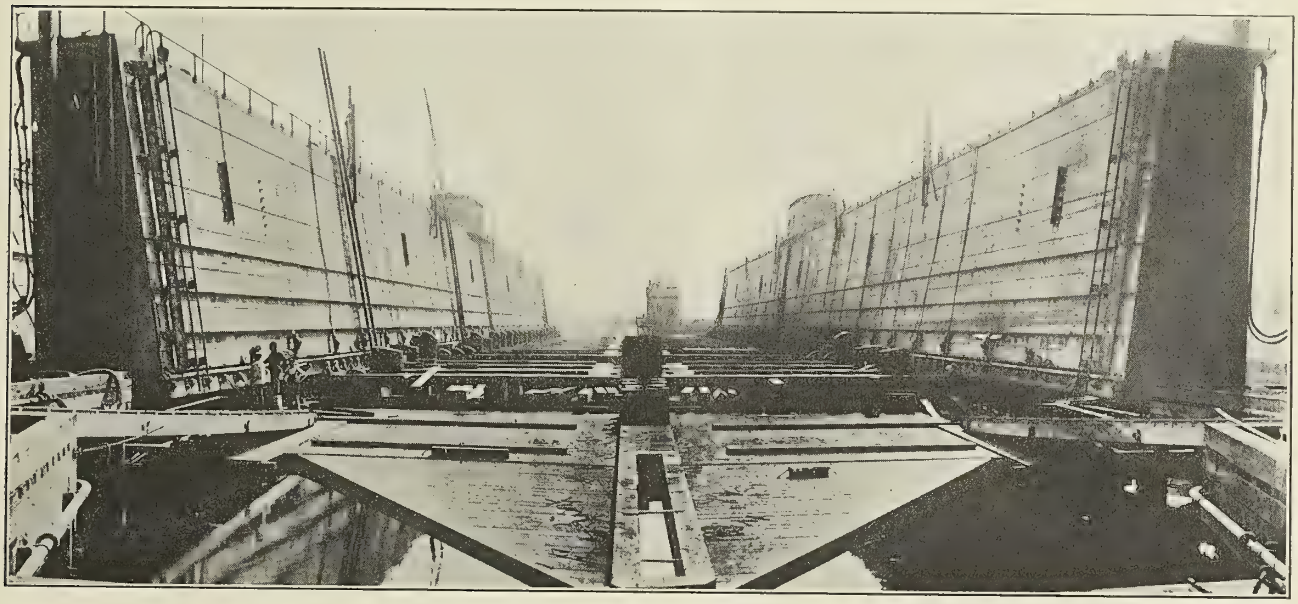


FIG. 2.—INTERIOR OF THE DOCK. FIRST AND THIRD PONTOONS DETACHED.

Attention is called to the longitudinal stiffeners on the outside of the wings. In previous drydock construction these stiffeners have been intercostal on the inside of the wing. It is very apparent that the construction has been simplified and the design very much improved by making these members continuous on the outside of the wing.

On 33-foot centers, or corresponding to the divisions between the pontoons, there is a water-tight bulkhead extending up to within 7 feet of the deck. It will be understood that while the bottom of the wing is continuous, to furnish rigidity to the whole structure, there is an open connection between the wing and pontoon, so that, as soon as the pontoon is full, the water can rise in the wing.

Attention should be called to the fact that the wooden pontoons contain no ballast, and that, when entirely full of water, they have still a buoyancy of approximately 100 tons each, and that the steel wings, containing 1,000 tons of steel, are just sufficient, with the added weight of machinery, to cause the whole structure to sink slowly when water is allowed to enter freely. By careful measurement, when the dock is submerged, it has been found that the total excess weight of the whole structure over its displacement is but slightly more than 300 tons.

PUMPING PLANT.

The pumping plant of the dock is operated by an electric motor located in a structure at the center of each wing. This motor is provided with an armature shaft extended at each end, and, through reduction gearing, drives a line shaft extending along the top of the wing. At a point above the center of each pontoon there is located a pair of cut-miter gears, the one on the line shaft being made a split gear. The weight of the vertical shaft is carried on a ball-bearing, and its location assured by a heavy base plate secured to the reinforced deck of the wing. The vertical shaft connects direct to a 12-inch centrifugal pump, taking its suction from the bottom of the pontoon and delivering water through the flood-gate. A cut-off jaw coupling is provided at the bottom of the wing, and a separate thrust bearing carries the weight of the impeller in the pump. It will be noticed that a small water connection is made from the volute of the pump to the thrust bearing, to insure water lubrication when the water in the pontoon is below the level of the pump. Suitable screens are provided to protect the suction of the pump and the flood-gate on the outside.

This manner of connecting and operating centrifugal pumps is used for the first time on this dock, and has proved of very great advantage. There are no valves to operate or care for other than the flood-gates.

In lowering the dock, the water enters through the flood-gates, passing through the pumps to the pontoons. In pumping the dock, the water is delivered through the flood-gates, and any variation of pumping can be obtained by operating the gates, or the pumping can be discontinued on any or all pontoons without stopping the machinery by simply closing the flood-gates. In lowering the dock, this system has been found to be of great advantage, in that the tendency for one side to settle faster than the other can be quickly and positively controlled without resource to the closing of the gates, by simply starting up the pumps on the side which is settling too rapidly. This operation affords double the power of control ever before secured, by not only stopping the entrance of water on the low side but instantly causing a delivery of water from the dock. This result is obtained by the action of one man in very much less time than has hitherto been found possible.

This system of pumping calls for a separate pump in each water-tight compartment, and as there are ten pontoons, each divided at the center by a water-tight bulkhead, there are twenty 12-inch pumps. Each group of ten pumps is operated by a 300-horsepower alternating-current electric motor. This pumping plant has been found to be of sufficient power to pump the entire capacity of the dock in thirty minutes.

FLOAT INDICATORS.

There is a float indicator, consisting of a galvanized float tank and indicator arm, extending up through the deck of the wing for each end of each pontoon, and also a float indicator for the water level in the wings. By observing the level of these indicator rods while the dock is in operation the dock-master may know exactly how the pumping is proceeding.

OPERATION OF THE DOCK.

The electric power for the operation of the dock is furnished by the local electric power and light company, and the controllers and operating switches are located in a building upon the bulkhead within about 50 feet of the shore end of the dock.

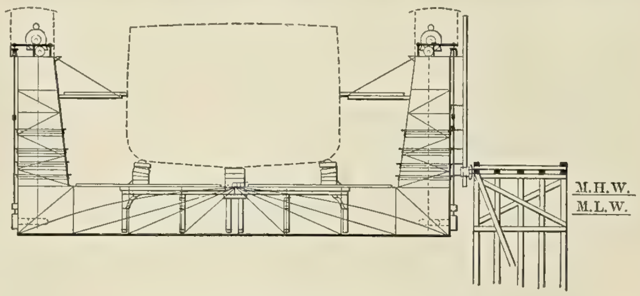


FIG. 4.—CROSS-SECTION OF THE DOCK.

The dock-master, in docking a vessel, stands on the pier in front of the dock, and by walking a short distance to the right or left, he can see down each side of the vessel.

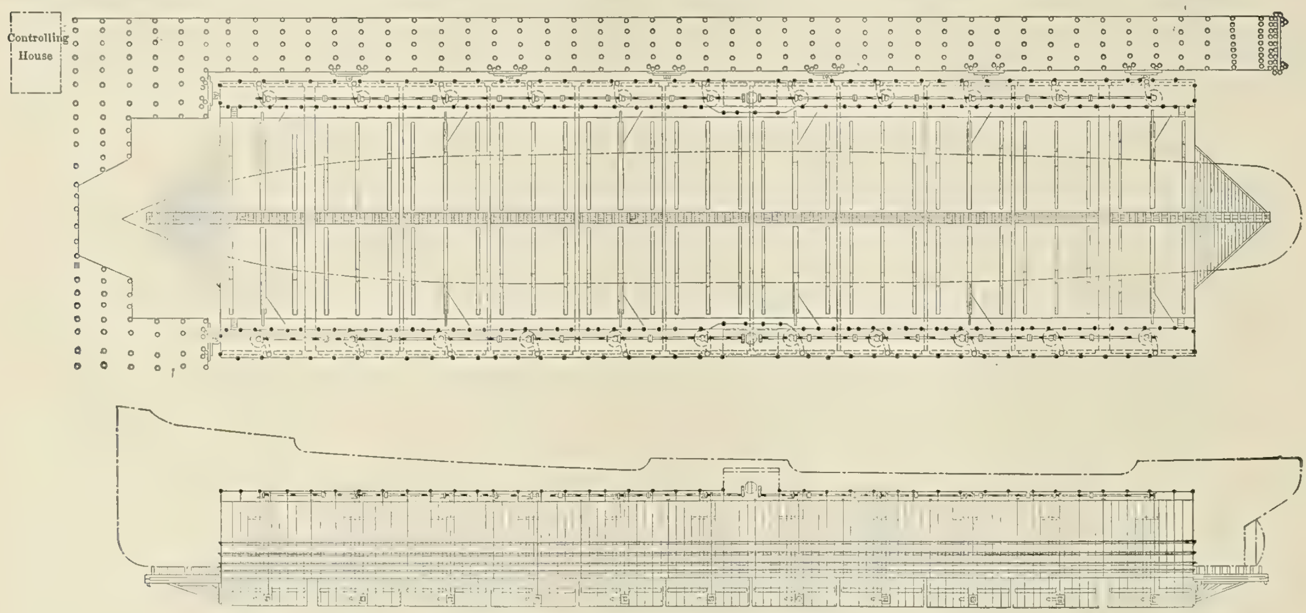


FIG. 3.—PLAN AND ELEVATION OF THE DOCK.

When the dock is lowered, ready to receive a vessel, the tugs (two or more) which are handling the vessel, enter the vessel at the outer end of the dock. Bow lines are passed to the top of each wing, and as the vessel is pushed into the dock by the tugs it is kept central by snubbing the lines on either wing. When the vessel has entirely entered the dock, bow and stern lines are led to hand gypsies and used to center the vessel. Quarter lines are used to place the vessel fore and aft.

When the desired location has been approximately determined, the side trammels are lowered and the vessel ac-

curately centered. During this time the keel blocks are from 1 foot to 2 feet below the bottom of the vessel. The machinery is then started up and pumping continued slowly until the keel blocks are in contact with the keel of the vessel. Pumping is then continued more rapidly, until the vessel has been raised about 1 foot, when it is slowed down or stopped until the bilge blocks have been drawn under the bilges, when the pumping is continued more rapidly, until the vessel is entirely out of the water.

If a vessel is of the full length of the dock, little or no manipulation of the flood-gates is necessary, the lateral sta-

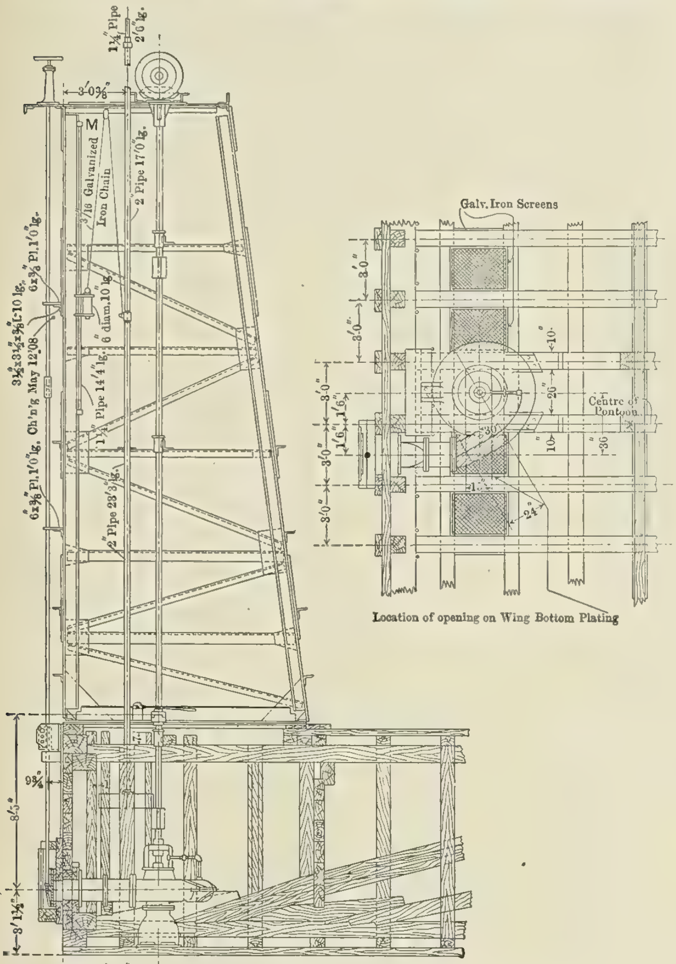


FIG. 6.—SECTION OF WINGS, SHOWING LOCATION OF PUMP.

bility or roll of the dock and vessel being controlled by the speed of the pumping, which is entirely independent on each side.

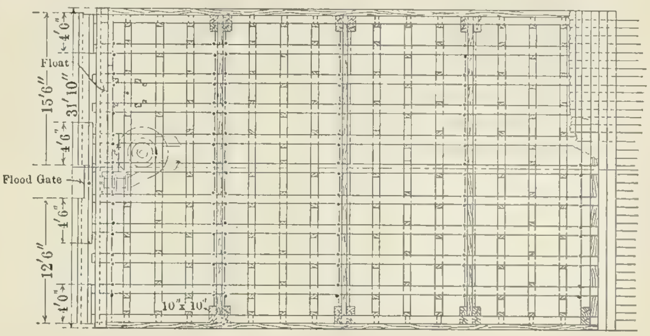
If the vessel is much shorter than the dock it is always placed at one end, and, as the lighter end tends to come up more rapidly, the flood-gates, which are the outlets for the pumps on that end, are gradually closed a sufficient amount to cause the dock to maintain a horizontal position longitudinally while rising.

It will be understood that the rolling or transverse stability is entirely independent of the longitudinal stability, and is, at all times, controlled by the man in charge of the controllers under the direction of the dock-master.

FACILITY FOR UP-KEEP AND SELF-DOCKING.

As the dock is secured to the pier work only on one side, with ample free space on the other side, any pontoon may be detached and self-docked at any time. While there has, as yet, been no occasion to self-dock a pontoon, several pontoons have recently been detached from the wings for the purpose of replacing sheet steel packing with canvas packing between the wings and pontoons.

To detach a pontoon, the steel wedges are driven out and the links thrown down around the lower pin on the pontoon. The gate rod on the outside of the wing is disconnected at a level with the deck of the pontoon, and the indicator rod for the pontoon float is also disconnected. As there is a jaw-



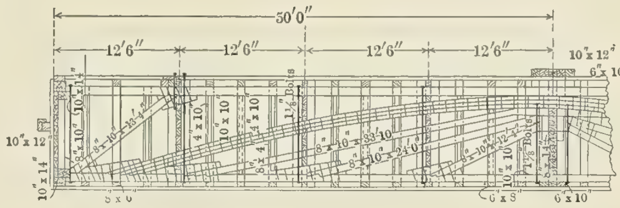


FIG. 6.—HALF SECTION OF PONTOON.

coupling connection at the level of the pontoon deck in the vertical shaft driving the centrifugal pump, this will separate of itself. After these parts have been disconnected, the pontoon will remain in contact with the wings, being held there by its proportionate load in supporting the wings. The remaining part of the dock, which, as a whole, has had a free-

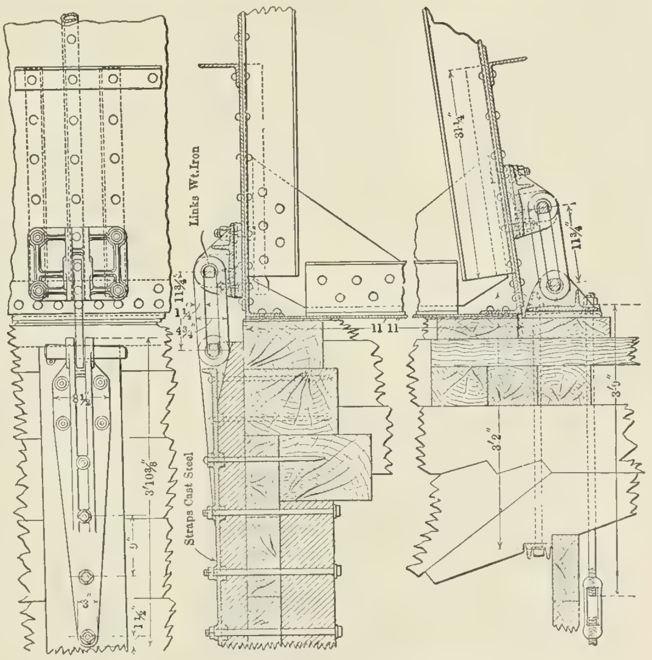


FIG. 7.—DETAILS OF CONNECTION OF PONTOONS AND WINGS.

board of about 1 foot, is then pumped up. As the wings weigh 1,000 tons, or 100 tons per pontoon, and the lifting power of each pontoon is approximately 100 tons per foot of depth, the detached pontoon will follow up the dock for about 1 foot, gradually being relieved of the load representing its share of the weight of the wing. From this point the continued pumping

of the dock will lift it above the detached pontoon. The pumping is then continued a sufficient amount to give free access for work between the deck of the pontoon and the bottom of the wing. Fig. 2 shows the first and third pontoons detached in this manner.

In the operation referred to, work on detaching a pontoon was commenced at 7.00 A. M. and by 3.00 P. M. three-ply canvas packing had been substituted for No. 10 steel plate, the canvas thoroughly saturated with red lead, the bottom of the wing on each side of the dock scraped and painted two coats of red lead, and the pontoon returned to place and secured.

TIME OF BUILDING.

Work on the dock was commenced April 23, 1908, and the first ship was raised Feb. 2, 1909, an elapsed time of nine months and ten days.

The pontoons were furnished complete by Harry Cossey, of Tottenville, S. I. The steel wings were furnished and erected by Post & McCord, of New York. The centrifugal pumps were furnished by the Morris Machine Works, of Baldwinsville, N. Y. The electric motors were furnished by the Western Electric Company. The transmission machinery was furnished and installed by Tracy Bros., of New York City.

During the first two months after completion twenty-four vessels were docked, having an aggregated registered tonnage of 78,061.

As the dock-master and his assistants became familiar with the operation, some very rapid work in docking vessels was accomplished. On several occasions a vessel has been let off in the morning, another vessel put on and painted, that vessel let off in the afternoon, and a third vessel put on the same day.

Recently the turbine steamer *Yale,* of the Metropolitan Line, arrived at the entrance to the dock at 12.00 M., and by 3.00 P. M. was again in the water, having had a wheel removed and a new one substituted, this dispatch saving the loss of a trip, a very important matter in the summer season.

MAST AND DERRICK MOUNTINGS.

13-INCH GYN BLOCKS.

Fig. 1 shows a 13-inch gyn block for 5-ton and lighter derricks. The diameter of sheave is 13 inches, thickness 2 inches. The sheave pin is 1¼ inches diameter, with a feather at the head to prevent turning, and a ¼-inch screw in the nut to prevent the nut working loose; the pin is grooved for oil flow. From the center of the sheave pin to the underside of the crown is 12 inches, and from the center of the sheave to the center of the ⅝-inch bolt in the distance piece is 9 inches. The crown of the block is 2½ inches deep, 4¼ inches broad and 3¾ inches long. The jaws of the block at the crown are 3¾ inches broad by ¾ inch thick, tapering to 2 inches broad by ½ inch thick at the distance piece. The guard is 20 inches over all by ⅝ inch thick. The swivel head is 1¾ inches thick, to suit a 1½-inch bowed shackle; the distance of the shackle pin above the crown being 2½ inches and the swivel 1½ inches diameter. The shackle pin is fitted with a split forelock.

DOUBLE BLOCKS FOR 10-TON DERRICKS.

Fig. 2 shows a 13-inch double block for the purchase and topping lifts of 10-ton derricks. The sheave pin is 2¼ inches diameter, grooved to allow oil to run. A feather is fitted at the head of the bolt to prevent the bolt turning, and a 5/16-inch screw is fitted in the nut to prevent the nut working loose with vibration. The cheeks are 5/20 inch thick and 13½ inches over all. The distance between cheeks is just sufficient to allow the sheave to revolve easily. The jaws at the crown are 3¼ inches broad by ¾ inch thick, tapering at the distance piece to 2¼ inches broad by ½ inch thick. The depth of block is kept at a minimum. From the center of the sheave pin to the center of the shackle pin is 13 inches, and from the center of the sheave pin to the center of the distance piece is 9 inches. The head is 2 inches thick, to suit a 1⅝-inch shackle;

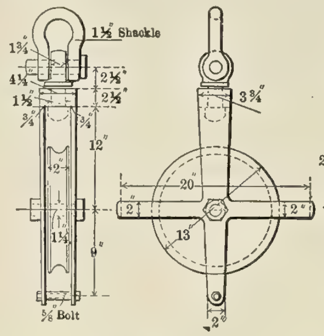


FIG. 1.

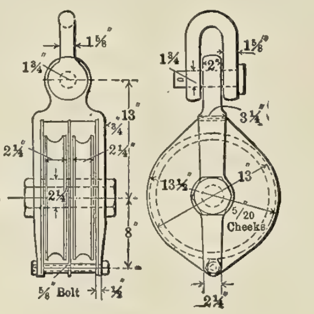


FIG. 2.

the pin of the shackle is 1¾ inches, and it is fitted with split forelocks. When these blocks are ordered for purchase and topping lifts, it is well to pay attention to the head fitting; one will be as shown, the other may have the head turned the other way.

SINGLE BLOCKS WITH BECKET FOR 10-TON DERRICKS.

Fig. 3 shows a 13-inch single block, with becket for topping lifts and purchases of 10-ton derricks. The sheaves are 13 inches diameter by 2¼ inches thick. The sheave pin is 2¼ inches diameter, with the usual grooves for oil, and with a feather at the head to prevent the bolt turning. From the center of the sheave pin to the center of the shackle pin is 13 inches, and from the center of the sheave pin to the center of the ¾-inch bolt through the distance piece is 8 inches.

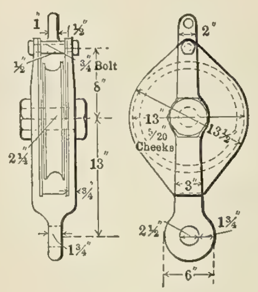


FIG. 3.

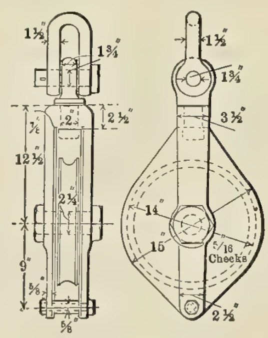


FIG. 4.

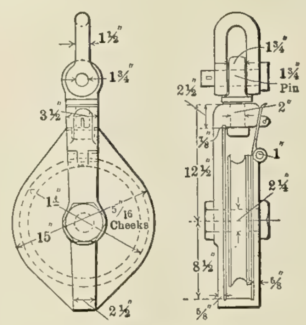


FIG. 5.

The jaws at the lower end are 3 inches broad by ¾ inch thick, and at the becket 2 inches broad by ½ inch thick. The depth of the block is kept as small as possible. The lower end of the block is worked into an eye, 6 inches broad 1¾ inches diameter, with a 2½-inch hole, suitable for taking the bow shackle of chain slings. The cheeks are 5/20 inch thick and 13½ inches diameter over all.

LIFT AND LEAD BLOCKS FOR 25-TON DERRICKS.

Fig. 4 shows a 14-inch swivel lift and lead block for a 25-ton derrick. The sheaves are 14 inches diameter by 2½ inches thick. The distance from the center of the pin to the underside of the crown is 12½ inches, and from the sheave pin to the center of the ⅝-inch bolt in the distance piece is 9 inches. The thickness of the crown is 2½ inches and the breadth 3½ inches. The swivel head is 1¾ inches thick, and takes the 1¾-inch pin of a 1½-inch shackle; the swivel is 2 inches diameter. The jaw at the crown is 3½ inches broad by ⅞ inch thick; the breadth at the distance piece is 2½ inches by ⅝ inch thick. The jaws are swelled in way of the sheave pin. The cheeks are 5/16 inch thick, and are 15 inches over all. The sheave pin is steel turned, grooved for oil, with a feather at the head to prevent turning and a screw in the nut to prevent loss. The pin of the shackle at the head is fitted with a split forelock.

In Fig. 5 is shown a snatch block for 25-ton derrick leads. The construction, however, is the same as that shown in Fig. 4.

A COMBINATION DIPPER AND CLAM-SHELL BUCKET DREDGE.

BY FRANK EDER, M. E.

A dredge involving some novel features of design was recently completed by the Maryland Steel Company, Sparrows Point, Md., for Mr. M. J. Dady, of Brooklyn, N. Y. It is a combination dipper and clam-shell bucket dredge, 100 feet long on deck, with a molded beam of 40 feet and a depth of 10 feet. The hull is of steel, with a complete steel deck securely braced by two longitudinal trusses running the entire length of the hull, and built up of heavy angles riveted to the deck and floor beams. Plate cords connect the double angles, and double-angle struts run diagonally between the top and bottom cords. This makes a very stiff and rigid construction, distributing the strains in the hull properly among the various bearing parts. A heavy channel stringer extends entirely around the frames on the sides and at the ends.

Four athwartship bulkheads are provided, that at the stern being watertight. This prevents any water which may come aboard through the after hawsepipe from filling any of the other compartments. Powerful steam syphons are also located in this outboard tank, so that it can be quickly emptied if necessary.

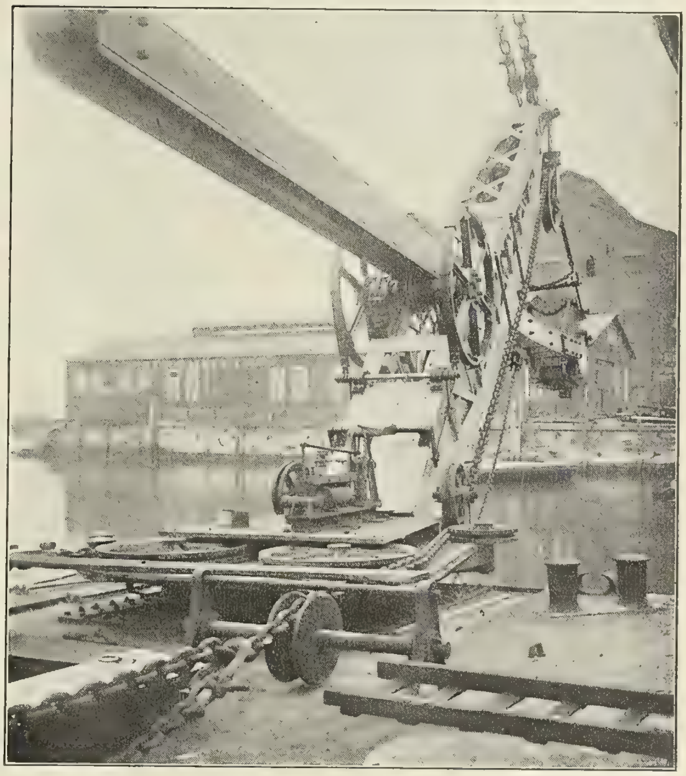


FIG. 2.—THE DREDGING APPARATUS.

Special attention was gven to the design of the spud wells and the outrigger. The two wells for the forward spuds are of heavy plate and angle construction. Inboard they are connected by a heavy steel truss, of the same construction as the two main longitudinal trusses. The spaces outboard between the spud wells and the sides of the hull are partially filled with cement. Heavy cast steel frames are riveted to the plates and angles at the top and bottom of the spud wells. An outrigger is provided to receive the stern spud. It is of heavy construction, designed to resist the severest blow, the motion of the spud being steadied by means of a cast steel cradle. All of the spuds are of the combined steel and wood type.

The arrangement of fenders is somewhat unusual, the customary horizontal fender being provided, extending entirely

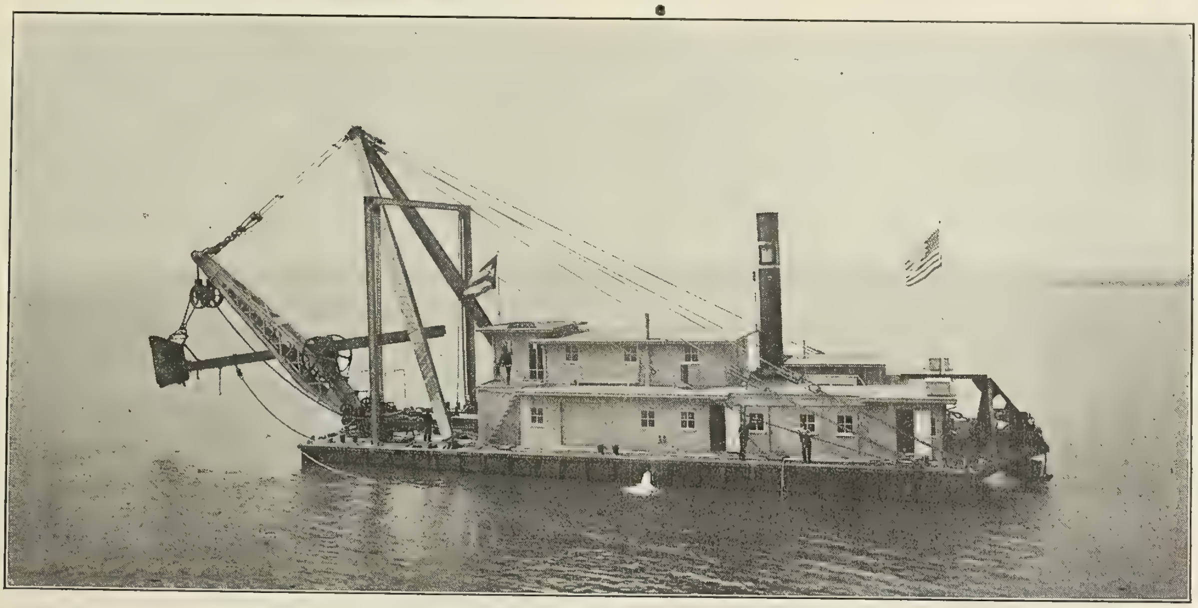


FIG. 1.—COMBINATION DIPPER AND CLAM-SHELL BUCKET DREDGE CHESTER.

around the deck. Perpendicular to this, forty-eight vertical fenders, each 3 feet long, are provided. This is to prevent the catching of the horizontal fender when the dredge is working alongside a scow.

The bottom of the hull is filled to a height of 7 inches with coke, the balance to the top of the beams being filled with a layer of concrete. This arrangement ensures a strong, tight bedded in the cement on the deck. The turntable itself was built by the Osgood Dredge Company, Albany, N. Y.

The boom is of steel, built in the form of a lattice girder, and is designed for a load of 120 tons. It is suspended by two wire cables, and a third heavy cable is provided for safety. The boom is 46 feet long, and at the widest point 5 feet 10 inches wide. Wooden fenders are fitted in the space through

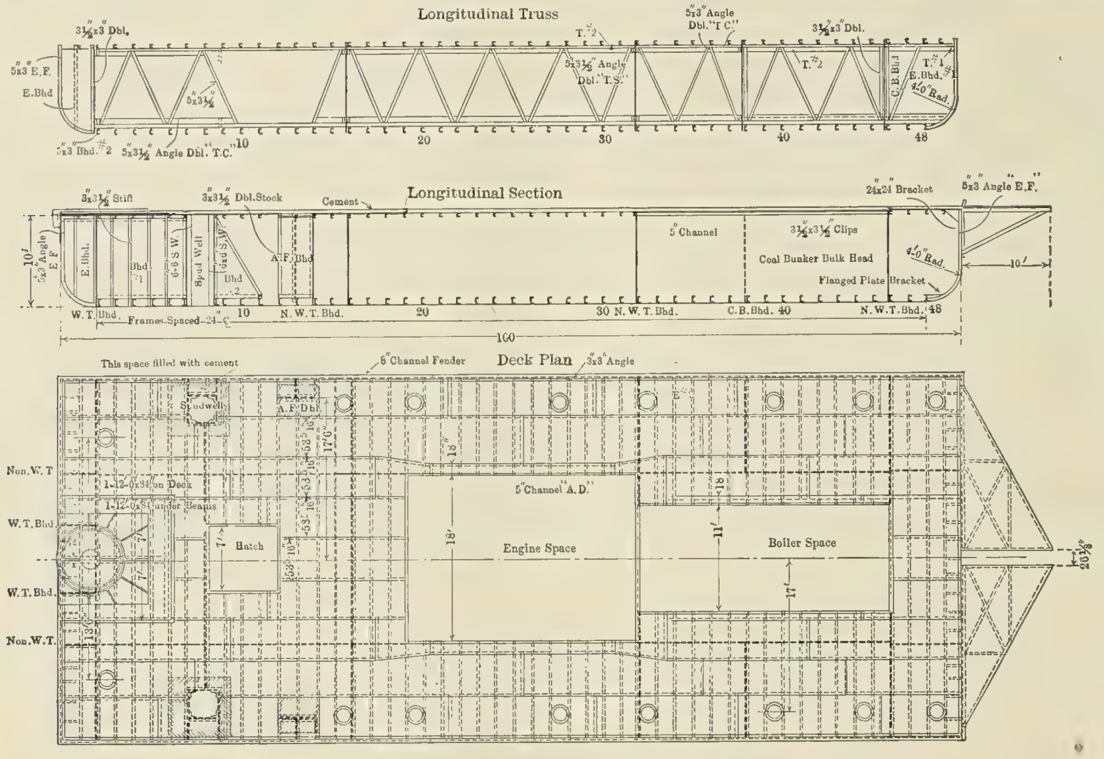


FIG. 3.—DETAILS OF THE CONSTRUCTION OF THE HULL.

hull, and about 60 percent of the weight is saved as compared with a solid cement floor. The main deck is likewise covered with cement, both inside and outside the deckhouse.

All castings used on the dredge are of steel, even the deck fittings, such as bits, chocks, cleats, rollers, etc. The entire turntable and turntable step are also of cast steel. In the turntable support a 14 by 14-foot heavy steel plate structure distributes the load over a large area upon the deck beams, which, in turn, are supported by an athwartship bulkhead and several heavy stanchions. Heavy counterplates are also located under the beams. The turntable down-bolts do not receive any of the side thrust of the load. A projection of the cast steel step is provided, resting on the bow which takes the side thrust. The turntable step, as well as all of the deck fittings, is em-

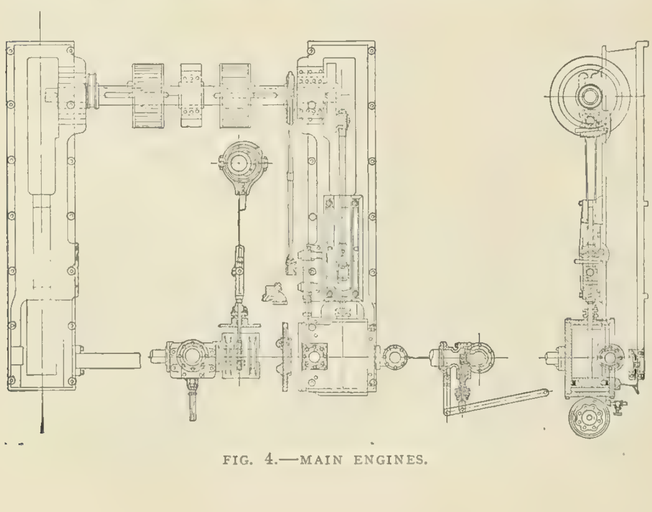


FIG. 4.—MAIN ENGINES.

which the dipper handles travel. All of the boom fittings, sheaves, etc., are of cast steel.

The *A* frame for supporting the beem is also of steel-lattice construction. It is designed for a load of about 140 tons, and is fastened to the hull by four plow-steel wire cables, each 2¼ inches diameter. A new feature is the arrangement of the two head sheaves over which the guys are led. By

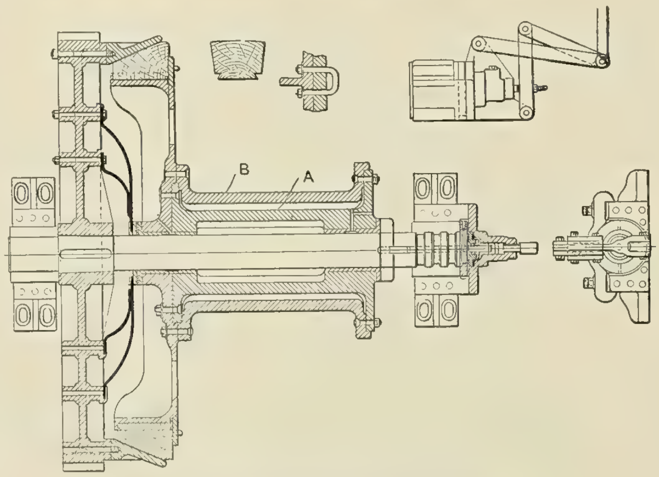


FIG. 5.—COMBINATION WINDING DRUM.

this arrangement the strain on the starboard and port guys is automatically equalized. The height of the *A* frame from the deck to the center of the swinging head is 50 feet, and the length of each leg about 60 feet. The head of the *A* frame overhangs the center turntable to a certain extent, rendering

a very steady, swinging motion. The gallows frame is also of steel, being of channel and lattice construction.

The dipper handle is 56 feet long and 22½ by 20 inches cross-section. It is of combined steel and wood construction, with cast steel rack and hinges. The dipper bucket has a capacity of 5, and the clam-shell bucket 6 cubic yards.

All of the machinery is placed below the main deck in the holds. The main dredge engine is a two-cylinder, double-geared engine, 18 by 24 inches, equipped with two dredge-friction drums and one backing-friction drum. By applying both frictions on the dredge drum the bucket is lifted, and by applying one friction the boom is swung. The setting of the frictions is done by Osgood's steam rams and the releasing by strong, steel springs. The combined arrangement for clam shell and dipper work is a new feature, which is accomplished as follows: When working as a dipper dredge the chain is wound around a 24-inch dredge drum (*A*, Fig. 5), but when working as a clam-shell dredge a split drum (*B*, Fig. 5) is placed over the 24-inch drum and securely fastened to its flanges, making a drum 34 inches in diameter and thus providing higher speed. The spud lift and capstan engines are 10 by 12 inches, of the same general design as the main engine. All of the engines were designed and built by S. Flory, Bangor, Pa. The engines are all controlled from the pilot house by means of an easily-working handling gear. Unlike many dredges, chains are not replaced with wire rope.

Steam is supplied at a pressure of 120 pounds per square inch, by a single Scotch boiler, 10 feet 8 inches in diameter, 13 feet 1¼ inches long, having a heating surface of 1,372 square feet. There are two coal bunkers, each having a capacity of 45 tons, and two water tanks, each 8 feet diameter and 8 feet long, having a capacity of 3,000 gallons.

The auxiliary machinery includes a complete air plant, comprising a Westinghouse air compressor and a complete outfit of pneumatic tools. Steam for the air compressor and the bilge and fire pumps, etc., when the main boiler is not in operation, is provided by a donkey boiler, 3 feet in diameter by 6 feet high. An unusually large condenser was found necessary on account of the high temperature of the water. It is a surface condenser, having 3,000 square feet of cooling surface, and works in combination with a feed-water heater.

The accommodations for the captain and crew are very well arranged, steel berths, concrete floors, large wash rooms, with hot and cold and fresh and salt-water shower baths, are provided, and all of the space is light and well ventilated.

The weights of the dredge and equipment are as follows:

	Pounds.
Steel hull, including fittings and concrete	725,000
Capstans and chain guides	25,000
A frame, complete	50,000
Gallows frame	10,000
Boom, complete with sheaves, etc	60,000
Dipper handle	35,000
Dipper bucket	15,000
Clam-shell bucket	10,000
Boiler	65,000
Engines	235,000
Condenser, filter box, pumps, etc	25,000
Donkey boiler	5,000
Piping	30,000
Spuds and spud gear	100,000
Superstructure	70,000
Total (light weight)	1,460,000
Water in tanks and boilers	60,000
Coal, etc	180,000
Total weight (loaded)	1,700,000

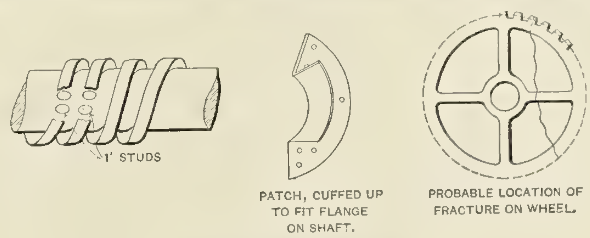
The dredge was named the *Chester*, and was designed by Mr. Austin T. Byrne, C. E. Her first station was at Matanzas harbor, Cuba.

BREAKDOWNS AT SEA.

A Broken Turning Wheel.

In some arrangements of turning gear a fracture of the turning wheel, or the worm engaging with it, will take place, if sufficient supervision is not exercised, owing to the fact that the drain pipe from the thrust-block well will splash salt water on the wheel unless this pipe is altered or a guard is fitted. The salt water drying with the heat of the engine room deposits a scaly covering on the wheel, which has a good mechanical resistance. Owing to the guard over the wheel this incrustation is not noticed, and when the engine is turned the worm wheel fails to pass through the teeth of the spur wheel, and causes either a fracture of the worm or of the big wheel on the engine.

Should this catastrophe happen the best way to repair the worm on short notice is as follows: The teeth are usually about 1¼ inches thick, and it is advisable to drill tap holes for



REPAIRS TO WORM AND WHEEL.

1-inch studs, in such a way that the studs are inserted in the broken part in a zigzag fashion, so as to fit into the teeth of the spur wheel. A little chipping and filing will make a sufficiently accurate worm surface to enable the boat to proceed.

If, however, it is the spur wheel that is gone, a patch must be placed on the wheel, so as to bind the fractured pieces together. As the wheel is made in two halves this is not a very difficult matter to accomplish, and the best form of patch is a piece of metal, cut to the required sector of a circle, and made to bolt onto the flange which goes round the shaft as well as to the sides of the wheel. The illustration indicates clearly the way in which these repairs can be effected.

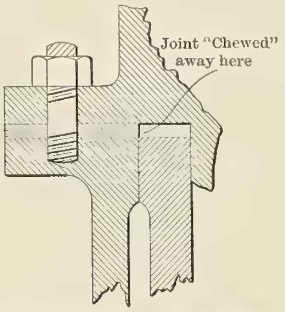
H. M. BROWN.

Strange Noises in the Cylinder of a Marine Engine.

During bad weather, when all parts of the machinery were subjected to the greatest stresses, a slight noise was heard in the high-pressure cylinder of the main engine of a steamship. This gradually increased to a sharp knock at each end of the stroke. As the weather was too bad to permit stopping the ship, and as the noise apparently got no worse, the engines were kept going until arrival in port, when the cylinder cover was lifted, the pistons were stripped, the piston nut tried over with a big hammer and all clearances tried. The curious thing was that nothing could be discovered in order to account for the strange noise heard while running. Everything appeared to be in perfect working order.

Rather mystified at the occurrence, the engineers put the cylinder again into working order without coming to any conclusion as to the source of the trouble. On leaving port again the noise was no longer heard, and the engine-room staff began to congratulate themselves on having overcome

the difficulty, although what they had done to do so was as big a mystery as the knock had been. Their elation, however, did not last long, as when the ship was about three hours out of port the click was again heard. Incidentally, almost simultaneously with the return of the click a stowaway was found, and the captain decided to return to port and hand him over to the authorities. On the way back the noise in the cylinder gradually developed into a sharp knock, precisely as it had done before, so that when the boat reached port again with its returned stowaway the cylinder cover was lifted and another attempt made to elucidate the mystery. Everything was gone over as before, but the problem remained as difficult as ever. Just as the cover was being prepared for replacement, the engineer who had jointed it on the previous occasion made a discovery. It had before this time been jointed with



SECTION OF CYLINDER AND LINER.

asbestos tape, but while in port asbestos mill board had been substituted for this. When the joint had been put on it had been made the full width of the flange. It was now discovered that the inside edge of the joint was cut about one-quarter of an inch back all around from the inside edge of the cylinder.

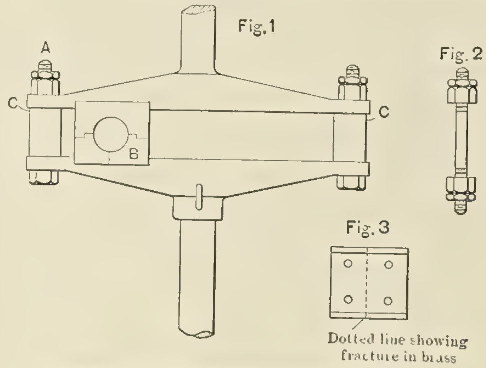
The mystery was therefore solved. The cylinder liner was loose in the cylinder, and it had been working up and down with the piston with every stroke of the engine. On first starting away the joint projected over the edge of the liner and held it in place, thus stopping the noise. As the joint was chewed or hammered away the liner again had room to move, and hence the return of the knock.

As the trouble was now discovered the liner was knocked down and clamped hard in its place, and a series of ¾-inch tap holes was drilled at intervals of about 8 inches apart round the cylinder, half in the liner and half in the metal of the cylinder. While the clamps were still in place the holes were tapped and fitted with tap bolts, which were afterwards cut off flush with the flange. The clamps were then removed and the cover replaced. It was then found on starting again that the noise had ceased, and although its occurrence happened some time ago there has been no resumption of this trouble on board the boat. T. S.

Breakdown of a Ballast Donkey Pump.

It very often happens that on board tramp steamers the spare parts of engines, and, more particularly those of the auxiliary machinery, are, generally speaking, conspicuous by their absence. The result is that when a breakdown occurs, which in practice usually happens at the least desirable moment, the best and quickest way out of the difficulty has to be sought, and this involves a certain amount of ingenuity. As a case in point, the breakdown of the ballast donkey pump of an old ship engaged in mercantile traffic may be cited. This was being used at the time to pump out the bilges during a time when the ship had a very heavy list to starboard. As the bilge connections on the main engines ran only to the center of the 'thwartship engine-room bilge, the foot plates in the starboard alleyway were flooded with water before the bilge water rose high enough to be pumped out by the main engines. Consequently, when the ballast donkey broke down the increasing amount of bilge water soon became a serious menace to the ship.

The break occurred when the donkey was being started, and a reference to the figure will show the portions which broke. These were the bolt marked *A* and the bottom half of the crank-pin brass *B*, both of these breaking at the same time. In order to replace the bolt *A*, inasmuch as there was no spare bolt to take its place, a piece of ⅛-inch round iron was secured, and threaded so as to take a nut and lock-nut at either end, as shown in Fig. 2. The next step was to take the



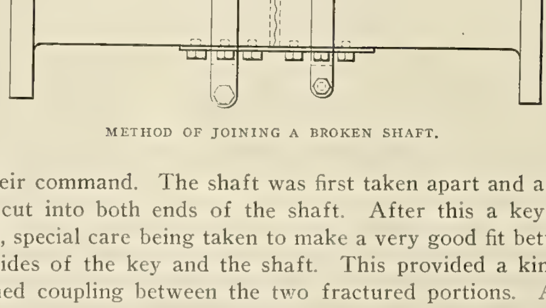
LOCATION OF FRACTURES ON BALLAST PUMP.

brass in hand. As there was not a piece of sheet brass on board sufficiently thick to make a strong patch, a piece of sheet steel, ¼ inch thick, was used instead. A portion of this was cut and fitted on to the sliding surface of the broken brass, and it was fastened by screwing four studs ½ inch diameter into the brass, and riveting the patch on, the holes in the patch having been previously countersunk. An allowance was made for the thickness of the patch by inserting two liner washers ¼ inch thick at either end, Fig. 1.

When the parts were reassembled and set to work, the donkey ran without giving any trouble, and, as a matter of fact, when a new brass was supplied at the end of the voyage the repair had worked so satisfactorily that the new supply was kept as a spare part. M. S. Haven.

Repairing an Intermediate Shaft.

The Bay of Biscay is responsible for a good many unfortunate breakdowns of marine machinery, and the effect of a collapse when in one of the storms which frequent this part of the Atlantic Ocean is very serious. One accident which occurred at this point was the breaking of an intermediate shaft in the center. This break was repaired at sea by the engineers on board the ship, with the few appliances that were



METHOD OF JOINING A BROKEN SHAFT.

at their command. The shaft was first taken apart and a key-way cut into both ends of the shaft. After this a key was fitted, special care being taken to make a very good fit between the sides of the key and the shaft. This provided a kind of toothed coupling between the two fractured portions. After this four key-ways were cut fore and aft on the circumference

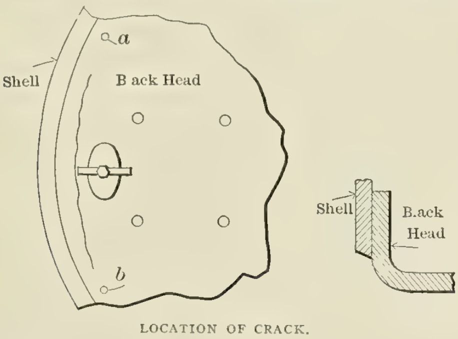
of the shaft and keys were made to correspond, one-half of the key lying on one part of the broken shaft and the other fitting into the other section. Six tap bolts were then fitted in each key, each tap bolt being 1⅛ inches diameter, this being the largest-size tap on board. After the shaft was put in place and the keys fitted in, two iron bands were brought round the keys and clamped in this position in order to strengthen the tap bolts. The whole arrangement was then as shown in the illustration, and it was found that with the engines going at their normal speed the ship was able to get to her discharging port and thence to a repair port without any further trouble with the shaft. CHIEF.

A Broken Check Valve.

One of the minor troubles which may afflict the marine engineer while at sea is the breakdown of one of the main check valves. The difficulty then arises as to how to keep the level of the water in the various boilers equal. Some men argue that the boiler on which the check valve is still sound and in working order will get more water than the boiler in which the valve is defective, inasmuch as on the up-stroke of the pump the water will return through the leaking check valve. Although this is affirmed by a good many engineers whose experience should enable them to judge accurately, it is not the case, judging by the writer's own experience, and it is quite possible that the delivery valves of the pump will prevent the water from returning on the up-stroke of the plunger. Moreover, the pipe is full of water, and it follows that the pressure of the water will cause it to flow over the easiest course, that is to say, through the bad check valve. This is because the water will not have the weight of the valve to lift in forcing its passage into the boiler. The practical point to remember, however, is that it is altogether too much of a big job to keep a constant watch on two boilers for six days, one of which has a broken check valve, and the simplest course to pursue in order to keep the water level in the two boilers equal is simply to work the boiler stop valves on the pump supply as checks; the water will then go to the boiler with the least pressure, and a check amounting to 2 or 3 pounds will be quite sufficient to regulate the supply to the boiler. S. HOWE.

Repairing a Cracked Boiler Head.

The sketch shows the position of a crack 16 inches long which developed in the heel of the flange of the back head of a Scotch boiler during a regular voyage of the steamship



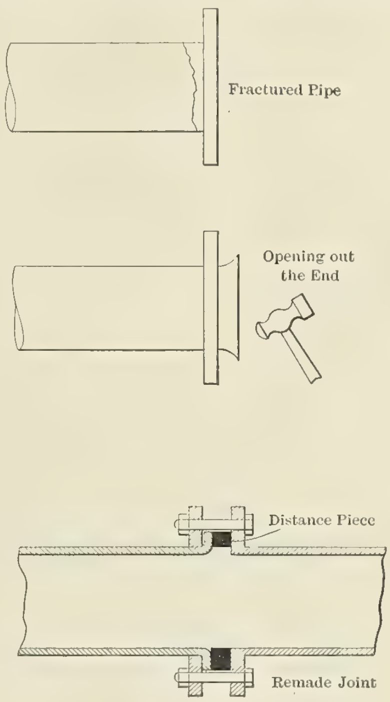
LOCATION OF CRACK.

H————. The boiler was cut out for repairs at 3.30 A. M., and cut in again at 6 A. M. the following day. It was a difficult crack to repair, because its location made the angle inconvenient for drilling.

A hole was drilled and tapped for a ⅝-inch tap bolt about 4 inches above the top end of the crack. This was to hold the "old man." Then a hole was drilled at the top end of the crack, tapped, and a ⅝-inch tap bolt screwed in hard and sawed off 1/16 inch above the surface of the plate. The next hole was placed so as to drill into the bolt already in place about 1/16 inch. This hole was also tapped and a bolt screwed in, and cut off in the same manner as before. This procedure was followed until the middle of the crack was reached, then, because the arm of the "old man" would not reach to support the drill for the remaining holes, the "old man" was clamped to the lowest tapped hole while hole *b* was drilled. The "old man" was then fastened at hole *b*, and the rest of the crack was drilled and plugged as before. Including holes *a* and *b* thirty-five bolts were used. The job has proved satisfactory, and nothing has been done to it since. "H."

Temporary Repair of a Fractured Feed Pipe.

One of the most frequent failings which is met in the design of marine machinery is that in the pipe connections for steam and water insufficient allowance is made for the effects of expansion and contraction. When the steam or water-pipe is made too rigid, or when no expansion bends are provided,



DETAILS OF JOINT IN FEED PIPE.

or when they are placed in the wrong position, the pipe frequently fractures close to the flange. The difficulty is enhanced if the fracture is situated too close to the flange to allow fitting a clamp or band over the broken part. In such a case a very good repair job can be made in the following manner:

The pipe length should be taken off and the flange cut away, as much of the pipe being saved as possible. Then take off the flange, cutting out all the pipe left therein, and pass the flange over the main length of pipe remaining, so as to leave about three-eighths of an inch length of pipe sticking through beyond the face of the flange. With the aid of a hand-hammer, using the pean to bead the pipe over, the pipe can be gently flattened out so as to overlap the opening in the flange. Great care should be taken, however, not to break the metal away.

The pipe will then be found to be anywhere from three-quarters to 1 inch short, and in order to make up this distance an iron or wooden distance piece should be fitted be-

tween the two flanges. A rubber circulating valve could be used, or even a ring-joint made from Tucks' packing, care being taken, of course, that the joint covers the beaded part of the pipe. If the work is carried through carefully it will be found that a first-class repair job can be effected. J. M.

A Broken Link Gear Rod.

As INTERNATIONAL MARINE ENGINEERING appears to be publishing some valuable notes on marine practice it may be interesting to relate the method which the writer adopted to temporarily repair a broken link gear rod. The accident occurred because the engine raced badly and carried away the drag rods at a bad weld. One of the contributory causes to

CLAMP FOR BROKEN LINK ROD.

this trouble was that the tumbling blocks had been left too slack. The defect, however, was not discovered until the fracture occurred, and the only thing then left to do was to repair it temporarily as quickly as possible, in order not to delay the boat. The two ends were brought together, and two or three strips of iron, about 3/8 or 1/4 inch across, were laid over the break. Then two strong clamps were made of brass, and the strips were bound firmly to the rod. This was a repair which, although not in accordance with mechanical ideas, was quite sufficient to bring the ship home to port, when the rod was rewelded. S. M. MITCHELL.

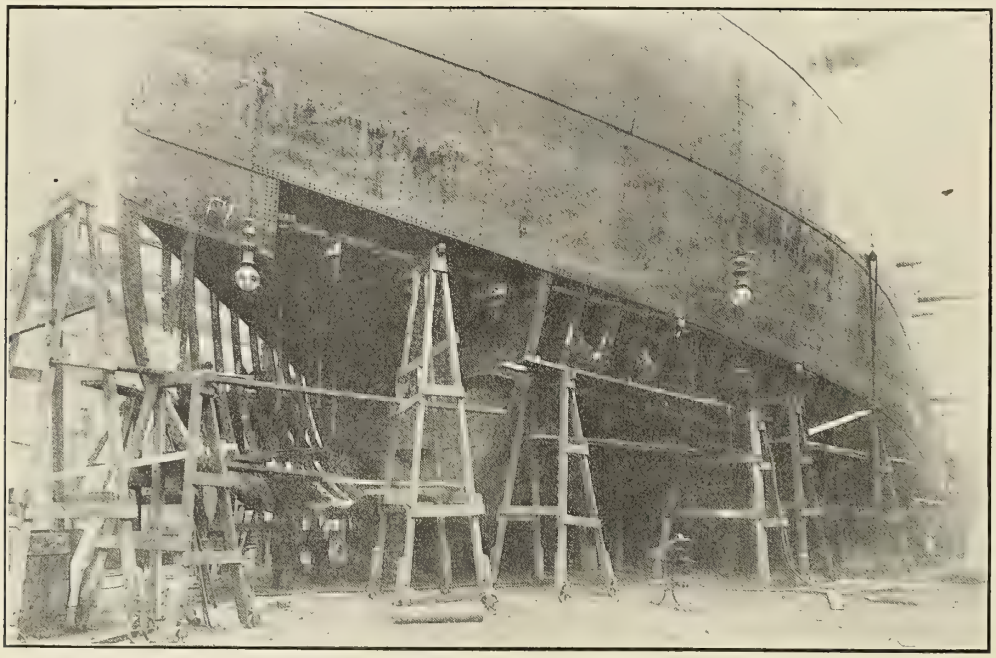
The Use of the Evaporator in Port.

It frequently occurs that a vessel is moored in a place where the water is bad, and it is then difficult to arrange for fresh water to replenish the boilers. A useful hint, which it is believed is known only to very few engineers, may be given as to the use of the evaporator for the purpose of supplying fresh water to the boilers. If the pipe arrangements are suitable it can be done in most steamers at very little cost. In the first place, the small feed donkey must be capable of drawing from the hot-well chamber; the ballast donkey should then be started through the condenser pumping the ballast, or if the ballast is out it is possible to pump the sea water through the condensers. The evaporator should now be started, and should carry about 1-pound pressure per square inch, working on the condenser in the usual way. The ballast donkey is also on the condenser, and the engineers can proceed with their ordinary work, taking care occasionally to pump out the salt well into the boilers and watching the condenser. It will be found by this means that a suitable supply of make-up fresh water can be obtained for the boilers. S. S. R.

Repairs to S. S. Stigstad.

The presence of an unusual amount of ice off the coast of Nova Scotia in the late spring was the cause of a number of minor accidents to steamships. The Norwegian steamer *Stigstad* was caught in an ice floe, and her bow was considerably indented by contact with the ice. As she was leaking badly, she put into Halifax for repairs. The vessel was docked by the Halifax Graving Dock Company, Ltd., and thirty-five plates were repaired. Nine of them were replaced with new ones, sixteen were removed, furnaced, faired and replaced, while the rest were faired in place. Seven frames were also taken out of the peak and replaced with new ones. The work was finished in thirteen and one-half working days. Repairs were rendered difficult by the fact that the steamer is of the side-tank type, having an inside skin extending up the side of the tank from the margin, the space between the two shells being only 2 feet 9 inches wide.

The *Stigstad* is a single-screw steamer of 4,688 gross tons. Her length is 363 feet; beam, 52.2 feet, and depth, 29.1 feet. Propulsion is by a triple-expansion engine, having cylinders 26, 40 and 70 inches in diameter, with a stroke of 48 inches. She was built in 1908 by W. Gray & Company, Ltd., West Hartlepool.



S.S. STIGSTAD IN DRYDOCK, SHOWING EXTENT OF REPAIRS.

Mr. H. J. Cornish, chief ship surveyor of *Lloyd's Register of Shipping,* has retired after forty-six years of service with the company. Mr. S. P. J. Thearle has been appointed his successor.

THE MARINE STEAM ENGINE INDICATOR — II.

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

PENCIL MECHANISMS.

The piston movement of all classes of indicators—"optical" indicators excepted—is multiplied at the pencil or scriber by a mechanism which bears the somewhat inappropriate name of "parallel motion." Some of these mechanisms give an exact copy of the piston movement, both in the straightness of the line drawn and in proportional motion, but the majority of them only approximate an accurate straight line. As will be seen hereafter, proportionality or velocity ratio depends on the accuracy of the straight line, and errors in this respect go hand in hand with the deviation of the scriber from its true path. It should be borne in mind, however, that the deviations from absolute exactness are mostly mathematical, the errors not being easily measurable when the mechanisms are used within their designed range. The kinematic principles, which will be described here, are well known to all indicator manufacturers, and the departures from theoretically correct movements have been made by them for the purpose of reducing weights, inertia effects and friction, or increasing the stability of the mechanism according to the individual ideas and experiences of the various designers.

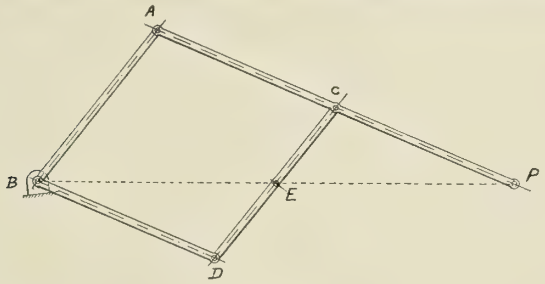


FIG. 16.

Link-work mechanisms, strictly speaking, are those containing only turning pairs, sliding pairs being entirely omitted.[1] The first of the exact link-work mechanisms was invented as late as 1864 by M. Peaucellier, a French engineer officer. This mechanism contains seven bars and is unsuitable for indicator work. Other arrangements containing fewer links have since been invented, but none of them is suitable for the indicator pencil motion.

THE PANTOGRAPH.

Because of the geometrical principles involved, and the frequent use made of these principles in all classes of indicator work, the engineer should be familiar with the simple link-work parallelogram, commonly known as the pantograph. In its simplest form it consists of four bars connected by turning pairs, the opposite bars being of equal length to each other.

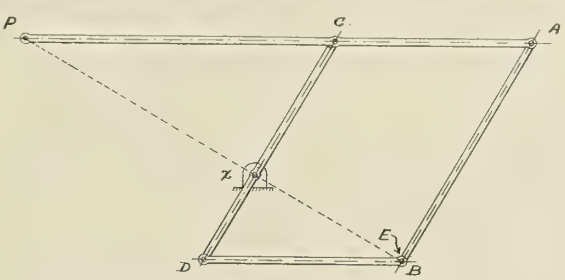


FIG. 17.

[1] In kinematics, pin joints permitting rotary motion only, are called turning pairs. A bar and guide or a slot and block constraining a point to movement in a predetermined line is known as a sliding pair. The cross-head and guide of an engine is a sliding pair, and the crank pin and bottom end connecting-rod brass a turning pair.

In Fig. 16 the four links AB, BD, CD and AC form the parallelogram. AB equals CD in length, and AC is equal to BD. The link AC is extended to P and may be made of any desired length. The point B turns about a stationary support. Draw the line BP and locate E at the point where it cuts the center line of CD. Then in whatever position the mechanism be placed, the three points, B, E and P, will lie on the same straight line,[2] and any motion imparted to E, whether curved, irregular or straight, will be copied by P, but on an enlarged scale, the ratio of enlargement being $BP \div BE$, or what is the same thing, $AP \div AC$. In Fig. 17 the principle is the same, but the layout quite different. Here the fixed point is at x, one "marking point" is at P as before, while the other scribing point E coincides with the pin B. All the motions of E will be copied at P as in the first instance, but in an opposite "sense."

In Fig. 18 we have a conventional sketch of the pantographic pencil mechanism as actually applied to an indicator of American manufacture. The piston rod—whose center line is FG—is guided by the piston itself and the sliding pair at E, and is attached to the parallelogram at D. As D is constrained to move in a straight line, the pencil at P must also move in a straight line. As the pencil motion will be a mathematically exact copy of the motion of the point D, it is seen at once that the piston, piston rod and guide must be accurately in line, must have a nice fit and be kept in this condition, as any inaccuracy or "shake" at this point will be much exaggerated at the pencil. In the Hädike indicator the link HD is raised to the position $H'D'$ in order to avoid a multiplicity of joints at D, and in the Elliott instrument this link is extended to D'', the piston rod being joined at that point. The pantographic principle is the same, however, in all three designs.

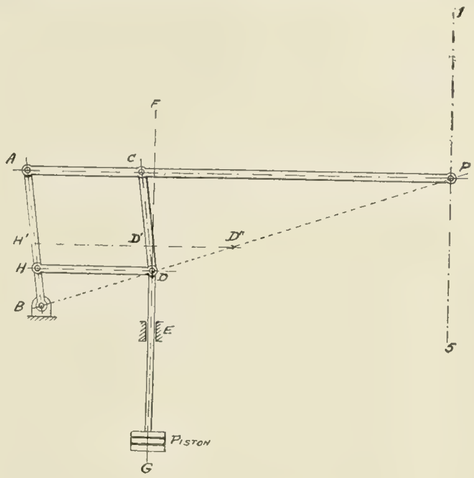


FIG. 18.

If, in addition to the links shown, a straight guide is fitted to keep the point P in its straight path 1-5, the rod HD may be removed and the motion will not be altered, because AB and CD will remain parallel, BDP will always be in the same straight line and the velocity ratio $\frac{BP}{BD}$ will remain constant.

[2] By geometry: "If a line be drawn between two sides of a triangle (in this case AP and BP) parallel to the third side (AB), the triangle formed (CPE) is similar to the given triangle (APB)." Also "if two triangles are similar, their homologous sides are proportional." As AB and CE are parallel by construction, these theorems apply here and $\frac{CE}{AB} = \frac{CP}{AP}$. Multiplying both sides of the equation by AB, we have $CE = \frac{AB\ CP}{AP}$ from which we see that E must always occupy the same place on CD, because the second or right-hand member of the last equation is composed of constant factors. The proportion $BP:BE::AP:AC$ is therefore constant. The same reasoning applies to all other forms of the pantograph.

Any deviation, however, of the points D or P from their accurately straight and parallel paths will destroy this constant velocity ratio, because the distance HD will no longer be a constant. This point should be borne in mind, as it explains why many instruments do not show absolute proportionality of movement between the piston and pencil.

THE WATT MOTION.

As its name implies, this motion was invented by James Watt, but was not applied by him to the indicator. A conventional sketch of the gear as applied to the instrument by Richards is shown in Fig. 19. The main levers AF and BE are of equal length, parallel when in mid-position and swing on the fixed fulcrums at E and F. The lever ends A and B deviate an equal amount on each side of the vertical center line (YY') at the middle and ends of the stroke. The pencil is at P, the middle point of the connecting link AB.

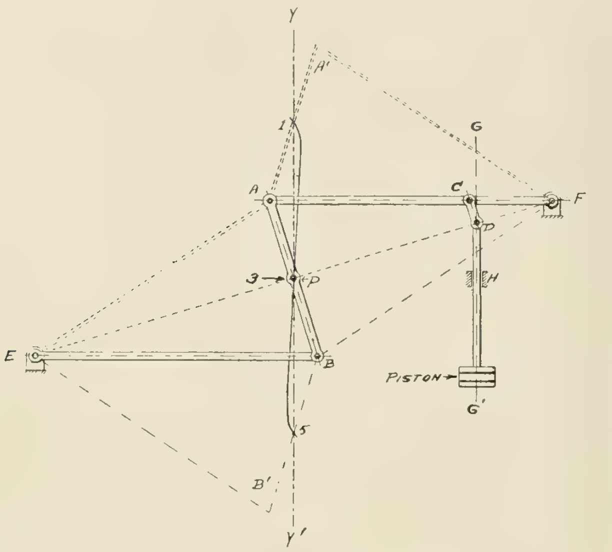


FIG. 19.

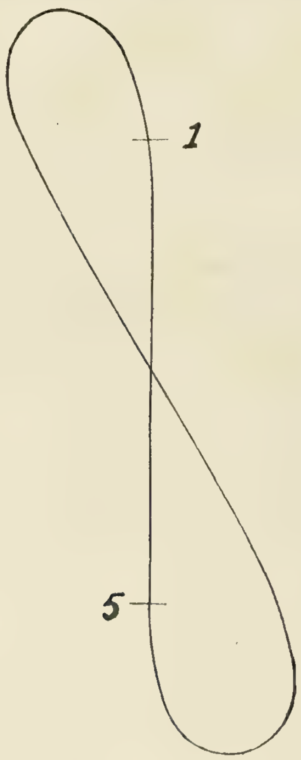


FIG. 20.

Fig. 20 shows the complete full size closed curve traced by the actual mechanism of an old indicator having a motion of this type. This figure is known in mathematical language as a lemniscoid. The part (1-5, Fig. 20) used for a straight line is, in reality, wavy, and has five points, which actually lie upon the line. The points are at the middle and each end of the stroke, and at two intermediate places. This is known as a "five-point" mechanism. It is possible, however, to so design the linkage that the three crossings nearest the middle of the stroke shall coalesce at the center, as shown in Fig. 19, which makes a "three-point" mechanism. The unbroken curved line 1-3-5, in Fig. 19, is the pencil path, its deviation being considerably exaggerated in order to show its characteristic form.

The center line of the piston rod is at GG' and is parallel to YY'. The piston rod connects to AF through the link CD. CD and AB are parallel when the mechanism is in mid-position, and also in every other position when the point P falls on the line YY'. The link CD is of such length that $CD : CF :: AP : AF$. This proportion locates the points P, D and F on the same straight line, so long as P is on YY' and D is on GG'. From what has previously been said on the pantograph, it is seen that the velocity ratio between the piston and pencil will be constant whenever D and P are on their proper axes, but in no other position. The double broken lines show the position of the main links of the mechanism at the upper end of its designed stroke, and the dash and double dotted lines the extreme lower position. It should be noted that the sliding pair at H bears no part in guiding the pencil in its approximate straight line.

(To be continued.)

Broken Bottles for Bridge Walls.

The burning out of bricks and the cracking of the cement in bridge walls have been a source of uneasiness to many marine engineers while on long voyages, when the fires are kept going for weeks at a time. The natural effect of partly-crumbled bridge walls is to consume more coal than is necessary. Such has been the writer's experience on several occasions when trading between England and the west coast of South America. In spite of the fact that the walls were built correctly and substantially at first, in time the bricks and cement would crack and break. We were at a loss at first as to what would be a reliable method to use in protecting them against the terrific heat of the fires. Finally, when port was reached, we hit upon the following expedient, largely through an experiment:

We secured about three dozen old bottles, breaking them up into small pieces about the size of a quarter. Then the bridge walls that were in the worst condition were rebricked and cemented all over with the usual mixture of fire-clay and cement, and the broken glass was embedded in the surface over the entire area exposed to the fires. This was done, of course, solely as an experiment, but to our great surprise and satisfaction the bridge walls held out during the remainder of that trip, and the following one, also, a period of over twelve months.

On examining the walls at the first opportunity, we discovered that the pieces of glass were melted by the heat and diffused over the entire surface, penetrating the cement to a depth of about ⅜ inch, forming practically a glazed surface over the whole wall. After that we always had a large barrel full of broken bottles for such work. This is a very simple method of keeping bridge walls durable, which is, as every engineer knows, a prime essential in the saving of time and coal—two goals which are greatly to be desired.

M. S. Olcott.

THE FERRY MISS VANDENBERG.

BY H. F. BENNETT AND L. E. BALDT.

This boat is the first double-end ferryboat to be launched in this country propelled solely by internal combustion engines. She was launched from the yards of her builders, the Pusey & Jones Company, at Wilmington, Del., on March 30, and was ready for delivery on May 15. She was designed by Mr. M. C. Furstenau, naval architect, of Philadelphia, Pa., and will be used for ferry service on the St. Lawrence River between Ogdensburg, New York State, and Prescott, Province of Ontario. She was built to full American Bureau of Shipping Rules, the rules being exceeded in many cases.

PRINCIPAL DIMENSIONS.

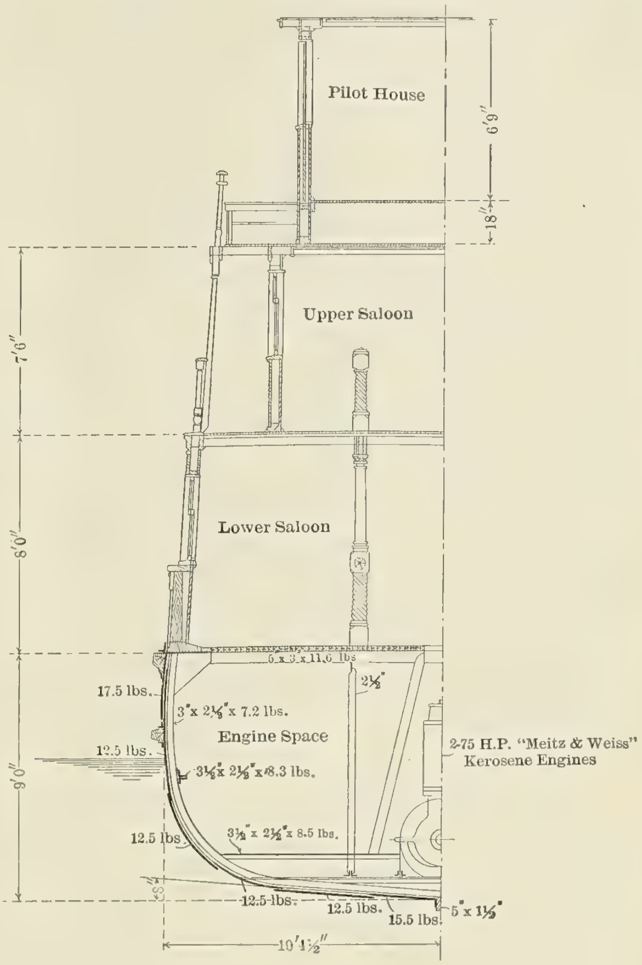
Length over all	100 ft. 0 ins.
Length between perpendiculars	79 ft. 0 ins.
Beam molded	20 ft. 9 ins.
Beam over guards	22 ft. 0 ins.
Depth molded at center line	9 ft. 0 ins.
Depth molded at ends	9 ft. 6 ins.
Load waterline	5 ft. 0 ins. above bottom keel
Displacement at	5 ft. 0 ins. waterline, 150 tons
Wetted surface	1,904 sq. ft.
Block coefficient	0.64

Tons per inch immersion at load waterline, 3.66.
Moment to trim 1 ins. at load waterline, 23.26 ins.

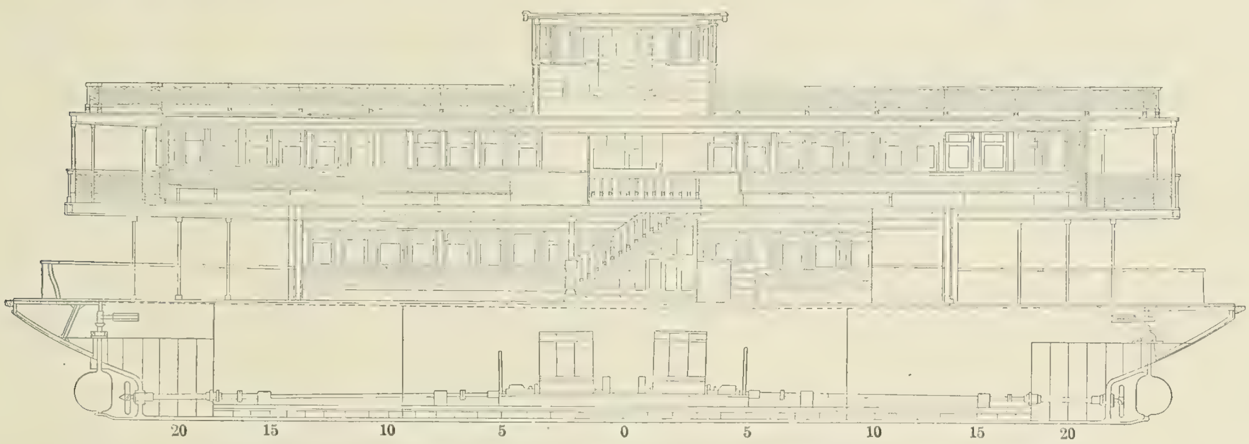
HULL.

The hull is built of mild steel throughout, with frames spaced 24 inches center to center, from amidships to a point 26 feet each way from amidships, and 18 inches from these points to the ends. The frames are 3 by 2½ inches by 7.2 pounds, with 2½ by 2½-inch reverse frames. The keel is of the bar type, 5 inches by 1½ inches. The shell plates are all 12.5 pounds, with the exception of the sheer strake, which is 17.5 pounds. The deck beams are 5 inches by 3 inches by 11.3-pound angles spaced every two frames from amidships to points 26 feet each way, and on every frame space from these points to the ends. The main deck is of 2¼ by 2¼-inch white pine laid fore and aft. Two white oak guards extend entirely around the hull, one at the main deck and the other at 6 inches above the waterline. These guards are fitted to the hull by 3 by 3-inch angles. They are capped with 4 by ¾-inch iron bars. There are four watertight bulkheads, dividing the ship into five compartments.

The bulkheads are built watertight, to conform with the American Bureau of Shipping Rules, with plates 7½ pounds to 10 pounds, vertical stiffeners 3 inches by 2½ inches by 7.5 pounds, spaced 24-inch centers, and horizontal stiffeners spaced 48-inch centers. There is a coal bunker fitted in one corner of the engine room 6 feet by 10 feet.



MIDSHIP SECTION.



INBOARD PROFILE OF FERRY MISS VANDENBERG, SHOWING LOCATION OF KEROSENE (PARAFFIN) ENGINES.

The stern posts are steel forgings, bossed to take the propeller shafts and stern tubes with a section 5 inches by 2¼ inches. The rudder is of the balanced type with steel frame and wood filling, the whole being covered with 12-pound steel plates. The rudder stock is 4 inches in diameter, and the frame has a section 2½ inches by 1 inch.

The floor plates amidships are 10 inches deep and rise at

the ends, as shown on the midship section. They are of 10-pound plate throughout; 2 by 4-inch limber holes are put in all floors, excepting watertight compartments. The center keelson consists of two 2½ inches by 3½ inches by 8.3-pound angles, riveted back to back, and to the reverse frames by clips 12 inches long. These clips are riveted to the floors on the opposite side of the reverse frames. The side keelsons consist of two 2½ inches by 3½ inches by 8.3-pound angles, riveted back to back, and to the reverse frames and to the floors on opposite sides of reverse frames. They are located 3 feet 6 inches out from the center line of the ship. The side stringers consist of two 2½ inches by 3½ inches by 8.3-pound angles, riveted back to back, and to the reverse frames and to clips 12 inches long, which are riveted to the frames on opposite sides of the reverse frames. They are located 4 feet 5 inches above the base line. At the ends they fair up with the top of the tanks, and are connected to them by gusset plates. There are two trimming tanks, one at each end of the boat, built of plates from 7½ pounds to 10 pounds, with vertical stiffeners 3 inches by 2½ inches by 7.2 pounds, spaced 24-inch center to center. The horizontal stiffeners are 3 inches by 2½ inches by 7.2 pounds, spaced 48 inches. There are two deck-beam stringers, each located 3 feet 6 inches from the center line of the ship. They connect by 5 inches by 3 inches by 11.3-pound angles, worked to double angle clips 2½ inches by 3½ inches by 8.3 pounds, 12 inches long, riveted to the deck beams. The deck stringer plates are 20 inches by 12.5 pounds, single butt strapped, double riveted.

PASSENGER ACCOMMODATIONS.

The main deck is closed in, except for a space of 10 feet from each end, and is fitted with slatted seats, toilets, wash rooms and newsstand. A wide stairway leads to the saloon deck. Access to the engine room is underneath this stair. The saloon deck is fitted like the main deck, with slatted seats. There is a companionway at each end of the boat to the main deck outside of the saloon deck house for the use of the crew for access to the pilot house. The pilot house is on this deck amidships; with a floor raised 18 inches above the level of the hurricane deck, it is fitted with two Williamson's hand steering gears.

EQUIPMENT.

The vessel is fitted with four metallic lifeboats 14 feet long, fitted with suitable boat davits and gear for lowering. There is one 300-pound Baldt stockless anchor, bedded in chocks and lashed at one end of the boat. Sixty fathoms of ⅝-inch stud-link chain is carried in a chain locker at one end of the boat. There are also 15 fathoms stowed in one of the peak tanks, which is fitted as a chain locker.

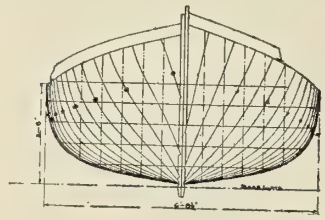
MAIN ENGINES.

The boat is propelled by two sets of three-cylinder Mietz & Weiss marine kerosene (paraffin) engines of 75 brake-horse-power each. Each engine drives an independent propeller, one at the forward end and one at the after end of the boat. The engines complete to the outer end of the thrust coupling weigh 3½ tons each. The shafting is of mild, open-hearth steel forgings, with couplings forged on each end of each shaft except the propeller and engine shafts. The intermediate shafts are 3 inches diameter, supported by two bearings, lined with Babbitt metal of the best quality. The propeller shafts are 3½ inches in diameter, and are carried at the bearings by ⅜-inch brass sleeves, ⅜ inch thick, projecting 3 inches beyond the glands and stuffing-boxes. The bearings on the outboard and inboard ends of the propeller shafts are both 15 inches long. The bearing sleeves are made in halves, and are removable, and are lined with best quality of lignum vitæ staves.

The stern tubes are of cast iron, turned at the bearings, and faced joints, and are thoroughly riveted in place at the inboard ends by a cast flange, and secured to the stern frame by a screwed nut on the tube. The usual oil and water service pipes are fitted.

PROPELLERS.

There are two cast steel propellers, one right-hand and one left-hand, fitted, of the following dimensions:



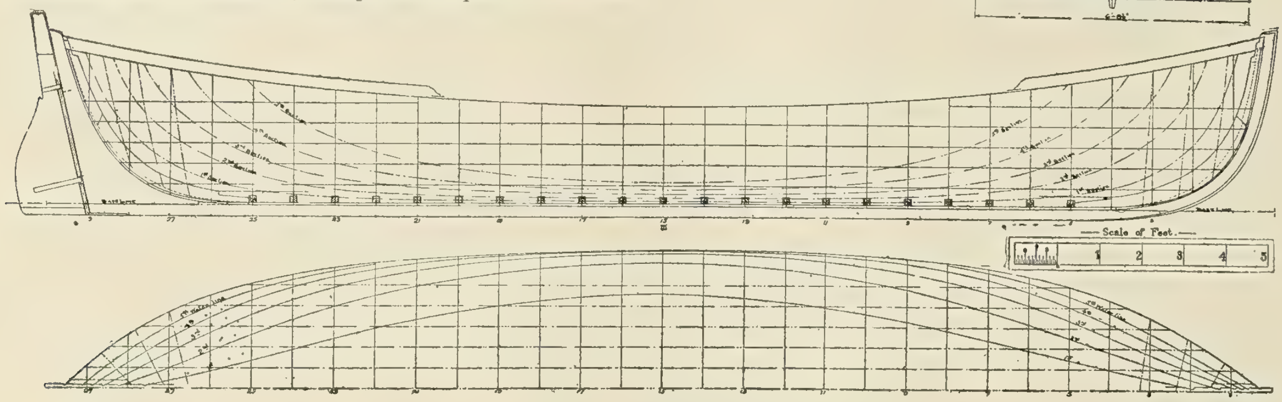


FIG. 1.—LINES OF 30-FOOT WHALEBOAT.

DATA.

Diameter	39 inches
Pitch	49 inches
Pitch ratio	1.26
Disc area	1,194.59 square inches
Developed area	593.9 square inches
Disc	.50
Number of blades	4
Rake	0 feet 0 inches

HEATING SYSTEM.

There is an Ideal six-section steam heater located in the engine room for heating the entire boat. The radiators are of the American Rococco type.

FUEL OIL AND OTHER TANKS.

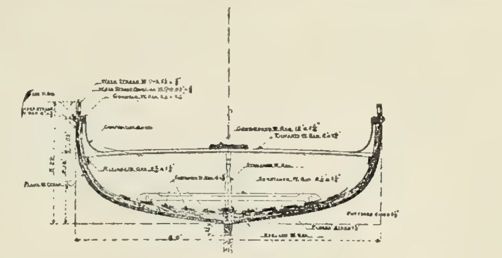
The fuel oil is carried in four seamless steel tanks manufactured by the Janney Steinmetz Company, of New York. They are 7 feet long and 20 inches in diameter, with a capacity of 100 gallons each.

There is also one seamless steel tank, 7 feet long and 20 inches in diameter, for fresh water, connected to a similar tank, 5 feet long by 20 inches diameter, for holding the com-

pressed air used in the sanitary system. Fresh water is forced to all parts of the boat by the Kewanee system of compressed air.

Complete sets of bell pulls from pilot house to engine room are fitted.

The exhaust from the main engines is carried up through the cabins to 2 feet above the pilot house. The pipes are 10 inches in diameter (standard wrought iron pipe), surrounded by a light steel casing 15 inches in diameter. This, in turn, is enclosed in a 20-inch sheet steel pipe and lagged with asbestos. The space between the 10-inch pipe and the 15-inch casing is used for a smoke-stack from the heater, and the space between the 15-inch pipe and the 20-inch casing is used for an engine-room ventilator. The exhaust piping in the engine room is covered with 85 percent sectional magnesia covering.



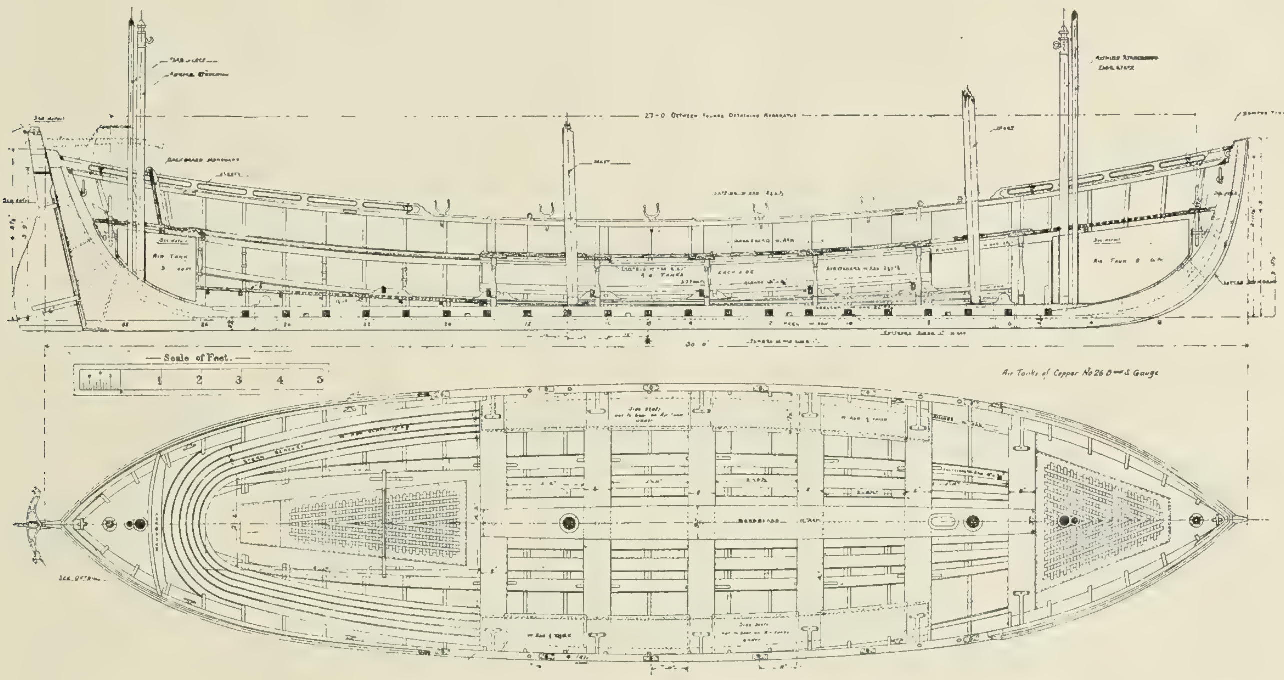


FIG. 2.—DETAILS OF CONSTRUCTION OF 30-FOOT WHALEBOAT.

A THIRTY-FOOT WHALEBOAT.

Fig. 1 shows the lines of a standard 30-foot whaleboat, such as is used in the United States navy. It is 30 feet long over all and 27 feet long between hangings; the extreme breadth is 6 feet 10 inches, and the molded breath 6 feet 8½ inches. From the top of the gunwale to the lower edge of the rabbet in the keel is 2 feet 5 inches.

Details of the construction of the boat are shown in Fig. 2. The keel is of white oak, sided 2¼ inches, molded below the rabbet forward and aft 3 inches, and tapered on the lower edge to 1⅝ inches. The stem, sternpost, deadwood, floor timbers, futtocks and keelson are all of white oak. The stem is sided 2¼ inches at the rabbet and 1 inch at the fore edge. The sternpost is sided the same at the rabbet and 1⅜ inches at the after edge. The deadwood is also sided 2¼ inches, to correspond with the keel. The floor timbers and the futtocks are sided 1 inch and molded at the throat 2 inches. The futtocks are 1 inch, molded at the head. Amidships the keelson is 2¾ inches, tapering to 2¼ at the ends. It rises 1¼ inches above the floors, and is scored down over the frames to the keel. The planking, excepting the sheer strake, is of white cedar ¾ inch thick. The sheer strake is of white oak, ¾ inch thick and 5 inches wide amidships.

The deadwood, stem and apron are all fastened with ½-inch copper bolts. The keelson is fastened with ⅜-inch copper bolts. Copper rivets, ¼ inch diameter, are used through the floors and futtocks, through the upper strake and 'thwart knees and through the 'thwarts and 'thwart knees. The sheer strake is copper-fastened with ten-penny rivets and nails. The garboard and the strake above it are fastened with twelve-penny copper nails, while the planking above the garboards is fastened with ten and eight-penny copper nails.

The boats are fitted with two masts and a slide gunter rig, the total sail area being 278 square feet. Both the foremast and mainmast are 15 feet 10 inches high, but the main topmast is 12 feet 2 inches long, compared with the fore topmast, which is only 11 feet 8 inches long. The masts are both 3 inches in diameter at the head and heel.

Exclusive of fittings the hull weighs 1,767 pounds. With the complete outfit on board, including awning stanchions, boat hooks, boat chest, tools, etc., a 5 and 3-gallon breaker, masts, sails, oars, row locks, rudder, grating, flag staffs, etc., the total weight is 2,342¼ pounds.

Regarding the Turbine Steamer Creole.

The following statement has been issued by the Fore River Shipbuilding Company, Quincy, Mass., builders of the turbine steamer *Creole:*

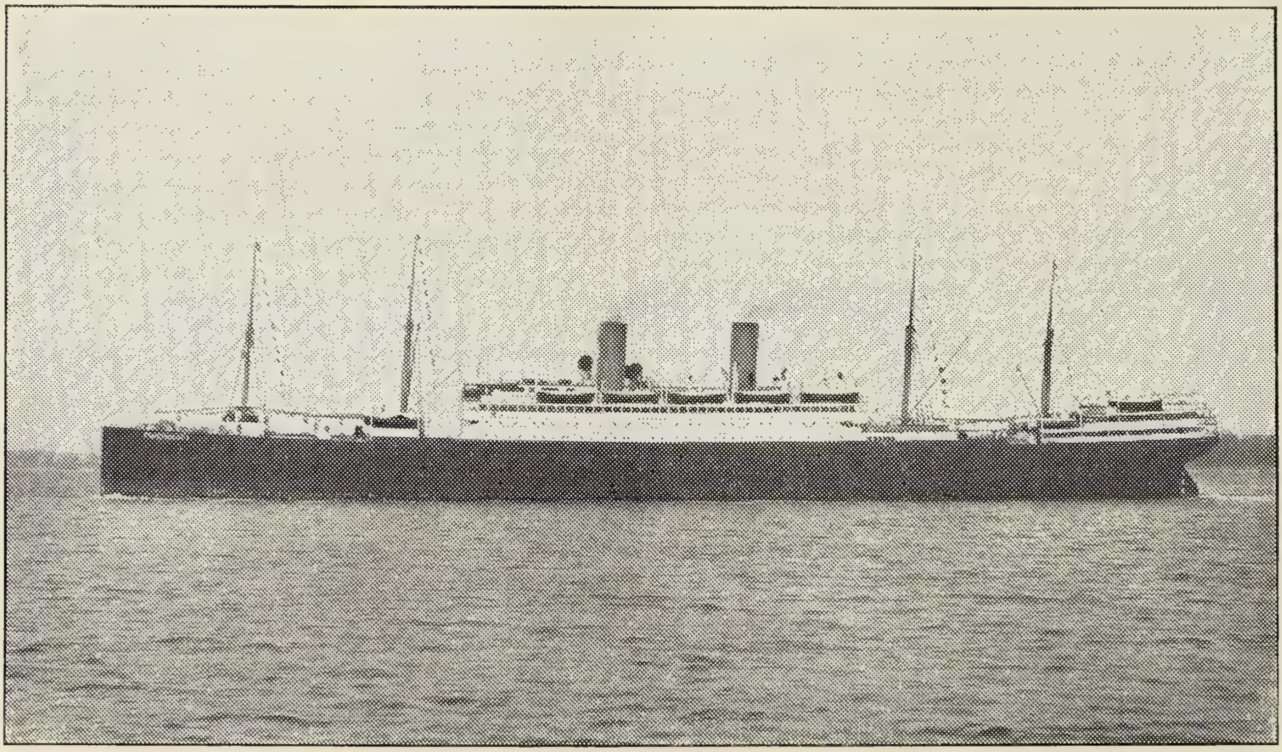
"The Fore River Shipbuilding Company contracted with the Southern Pacific Company for the building of the steamer *Creole* strictly on the owners' plans and specifications for the

hull, and agreed to install twin-screw Curtis marine turbines and Babcock & Wilcox watertube boilers. The shipbuilding company guaranteed that the vessel, under such arrangements as should be agreed upon between the parties to be proper, should show a speed of 16 knots on the round trip between New York and New Orleans in ordinary weather on 10,000 tons displacement and with a coal consumption not exceeding 7 tons per hour. The contract also provided that if the turbines and boilers did not prove entirely satisfactory to the Southern Pacific Company, and they decided to install reciprocating engines and Scotch boilers, the shipbuilding company would, if requested within six months after delivery of the ship, stiffen up the hull as might be necessary for this purpose.

"Before the delivery of the *Creole*, in December, 1907, the shipbuilders' installed a fourth set of screw propellers and made several trials of the vessel both light and loaded. The load draft trial run for a period of twenty-four hours in heavy weather showed that the vessel was able to meet the contract conditions, the speed and coal consumption having been measured and certified to by independent outside experts. On the measured mile at Provincetown the vessel showed 17.23 knots light as a mean of high runs and 16.57 loaded. A speed through the water of about 15¼ knots is sufficient to show 16 knots average round trip from New York to New Orleans. After this time the vessel made fourteen round trips to New Orleans, but failed on any trip to show the contract speed.

"The management of the Southern Pacific Company always refusing to provide a fire-room force either satisfactory to the shipbuilding company or in numbers and efficiency adequate for the type of boilers, met with continual and increasing difficulties in the operation of the watertube boilers. These boilers, on the builders' trials, were shown to have fulfilled the efficiency guaranteed, and were built by manufacturers whose experience in land and marine boilers is unexcelled. Although difficulties were encountered in obtaining efficient screw propellers for the *Creole* the shipbuilders continued to give this matter attention and had secured satisfactory screws. The turbines were shown on trial and in service to have obtained the designed efficiency and economy and to be successful in mechanical operation, notwithstanding the severe treatment which they received from excessive boiler priming, brought about by inexperience and carelessness in the fire-room. Notwithstanding the fact that the shipbuilding company installed assisted fire-room draft on the *Creole,* and carefully overhauled all auxiliaries on the vessel, subjected to unusual deterioration from the use of salt and muddy water in the boilers, and excessive priming from careless water tending, the boiler difficulties continued to increase until the vessel was laid up by the Southern Pacific Company, with the boilers in such condition that it was not safe to continue operation without careful overhauling.

"The Southern Pacific Company has demanded of the shipbuilding Company that they should remove the Curtis turbines and Babcock & Wilcox watertube boilers from the *Creole,* and install at their own expense reciprocating engines and Scotch boilers. The shipbuilding company, in declining to do this, maintains that the turbines, boilers and engine-room auxiliaries are exactly as were contracted for, and are capable under proper and intelligent operation of fulfilling the contract conditions. Considering the conditions of operation by the Southern Pacific Company, and particularly the scale of compensation of mechanical staff adopted by the company, it is probable that the operation of watertube boilers is not suitable, although they were recommended by and acceptable to the company's management at the time the contract was made. If the shipbuilders had sacrificed the greater turbine efficiency, due to the higher pressure and drier steam of the watertube boilers, and installed Scotch boilers originally, they are confident that the turbine equipment would have given satisfaction, and that the difficulties experienced are due to the conditions of operation of the watertube boilers, the turbines having stood punishment through which no reciprocating engine could have passed."



17,000-ton Hamburg-American liner Cincinnati.

THE CINCINNATI.

Two large, new steamships have been added to the New York-Hamburg service of the Hamburg-American Line this season. One of these, the *Cleveland*, was fully described and illustrated in the March, 1909, issue of INTERNATIONAL MARINE ENGINEERING. The other, the *Cincinnati*, which has just recently gone into service, is a sister ship of the *Cleveland*, the principal points of difference between the two vessels being in the interior decorations.

FIRST CLASS SALOON ON THE CINCINNATI.

The principal dimensions of the *Cincinnati* are:

Length between perpendiculars........	587 feet 6 inches.
Length over all........................	608 feet 8 inches.
Breadth on frames....................	65 feet.
Depth molded.........................	50 feet.
Load draft............................	32 feet 8½ inches.
Tonnage, gross register........(about)	17,000
Tonnage, net register...........(about)	10,000
Deadweight capacity, tons......(about)	13,000
Displacement on 32 feet 8 inches draft..	27,000 tons.

Cargo capacity, including fourth class passenger compartments, about 470,578 cubic feet.

Cargo, cold-storage room, about 35,000 cubic feet.

The main superstructure amidships extends to 100 feet forward and 154 feet aft the center of the ship, and is gradually tapered away to the uppermost deck. There are seven decks amidships: The lower, 'tween, saloon, upper, bridge, promenade and boat deck, while fore and aft of the propelling space one extra deck, the orlop, is fitted.

Steam is supplied at 214 pounds pressure by three single-ended and three double-ended boilers having a total heating surface of 23,000 square feet, and a total grate area of 525 square feet. There are two main engines of the four-cylinder, vertical, inverted direct-acting, quadruple expansion type, each capable of developing about 4,650 indicated horsepower at 80 revolutions per minute. The cylinder diameters are 29½, 42 29/32, 61⅜ and 86½, and the stroke 55⅛ inches. Each engine has a separate condenser with a cooling surface of 7,200 square feet. There are two three-bladed built-up propellers, which turn outboard when going ahead, the diameter of each being 19.4 feet, and the pitch 21 feet 8 inches (for more extended description of hull and machinery see INTERNATIONAL MARINE ENGINEERING, March, 1909, page 85).

As in other vessels of the Hamburg-American Line, the saloon accommodations on the *Cincinnati* are situated amidships, extending over four decks. They are connected by a grand circular stairway, as well as small companionways, and an electric elevator runs from the highest to the lowest deck.

The dining saloon is on the upper deck, and following the usual method now employed on ocean steamships, is provided with small tables seating two, four, six and eight persons. The dining saloon extends across the full width of the vessel, affording abundant light and ventilation.

The most spacious room on the upper deck is the lounge, where men are permitted to smoke, but from which the women passengers are not barred. Large, square windows insure a cool breeze at all times during the summer months, while a large, open fireplace adds cheer and warmth in the winter time. Connected with the lounge by a splendidly decorated vestibule is the first class smoking room, situated aft on the promenade deck. This room is surmounted by a dome of glass and is indirectly illuminated at night by a great number of hidden electric lights. From the vestibule the gymnasium, and also the Marconi wireless station, are easily reached by a companionway to the boat deck. Other features of the first class passenger accommodations include a photographer's dark room, music rooms, book stalls, library and information bureau, electric light baths, etc.

An innovation has been made in the accommodations for third class passengers. Comfortable staterooms for two, four and six passengers are provided instead of the customary dormitory arrangement. The third class passengers have a separate dining-room capable of seating 250 persons at a time. Ample sanitary accommodations are provided, and also a large deck promenade.

Eleven compartments are fitted on the lower 'tween and saloon decks to accommodate 2,064 fourth class, or steerage passengers, according to German Lloyds. Fixed ladders leading down the hatches for communication between the compartments and the upper deck promenade have been provided. Each compartment has a number of seats and tables, as well as cupboards, for the convenience of the passengers.

Every provision has been made for the safety of the 3,250 passengers which the liner is capable of carrying, including loud-speaking telephones to the various important stations on board the ship, wireless telegraph, sixteen lifeboats and ten collapsible boats, all carried on Welin quadrant davits, life

belts, submarine signals, Lloyd Stone's hydraulic bulkhead doors, large steam pumps, fire bulkheads in the deck erections, and steam and water fire extinguishing apparatus. The *Cincinnati* was launched in the yards of Blohm & Voss, Hamburg, in July, 1908, and she made her first trip to America in June, 1909.

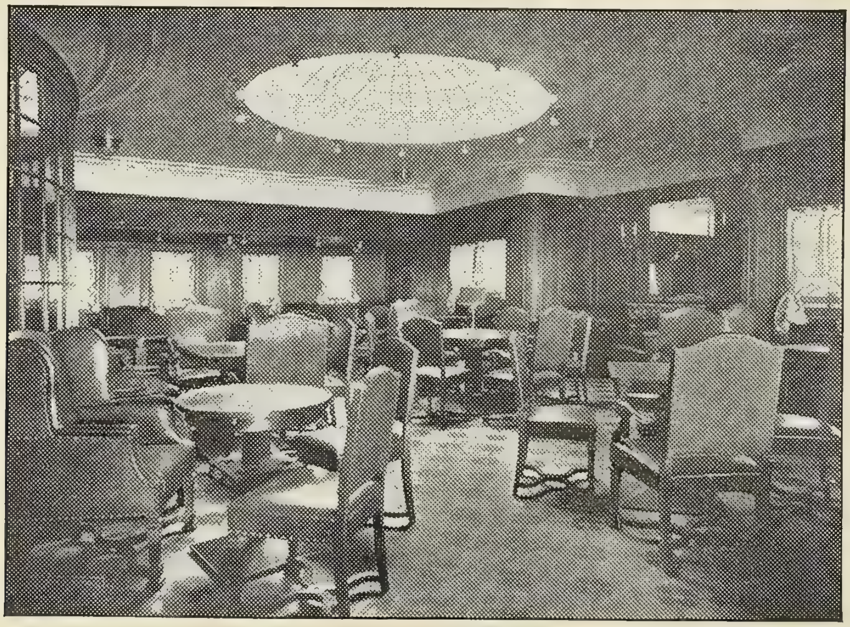
FIRST CLASS DINING SALOON ON THE CINCINNATI.

A SUCCESSFUL MARINE PRODUCER-GAS PLANT.

The motor boat *Marenging*, built for H. L. Aldrich, publisher of International Marine Engineering, and fitted with a producer gas power plant (see International Marine Engineering, March, 1909, page 110), has now been in commission for over two months, and has been given a thoroughly practical try-out. As announced in previous issues of this magazine, this boat was brought out solely for the purpose of finding out whether a producer-gas plant could be used to advantage in marine work; whether within the limits of the space and weight available in an ordinary commercial marine power plant a gas producer could be built which would produce a clean, rich gas from the ordinary coal which is available in every market.

The boat is 40 feet long over all, with a beam of 9 feet, and a mean draft of 3 feet 6 inches, and is driven by a four-cylinder, four-cycle engine, with cylinders 5¼ inches in diameter by 6 inches stroke, which turns from 400 to 500 revolutions per minute. The engine is fitted with a reversing gear, mounted in an extension of the main bed, and drives a solid three-bladed bronze propeller 24 inches in diameter.

The engine used on this boat is a regular stock motor, designed for using gasoline (petrol), the only changes made for producer gas being in the nature of considerably higher compression than is ordinarily met in gasoline (petrol) engines.



FIRST CLASS SMOKING ROOM ON THE CINCINNATI.

The inlet and exhaust valves and piping on this engine were exceptionally large, so that no changes were necessary on these parts. For the most successful operation on producer gas, the compression in the engine should be about 150 pounds per square inch. With this particular engine it was impossible to get much over 100 pounds, and, therefore, the results were not as good as could be expected with an engine especially designed for the service.

No attempt has been made to carry out tests involving extreme refinement because the inadequacy of the engine would make such tests of little value. What has been shown, however, is the fact that marine producer-gas plants can be successfully operated with remarkable economy. This has been well demonstrated to the satisfaction of the owner and many marine engineers and naval architects who have seen the plant in operation. Compared with a steam-power plant, this boat has shown remarkable economy, averaging a horsepower an hour on slightly over a pound of coal. In regular service the boat covers between 800 and 900 miles on a ton of anthracite pea coal, costing (depending upon where the coal is purchased) between $3.50 (14 shillings) and $5.00 (21 shillings). This amount of coal covers the banking of fires and starting up at frequent intervals. If the boat were started out on a continuous run, it is believed that it would make practically a thousand miles on a ton of coal The average speed of the boat is between 8 and 9 miles an hour.

Such a non-stop run was attempted on July 9, the boat leaving the Hudson River Yacht Club, at the foot of West Ninety-second street, New York City, at 4:48 P. M., bound up the Hudson River to Albany and return, a distance of 275 miles. Unfortunately, considerable trouble was encountered in navigating the boat in certain parts of the river during the night, as large quantities of eel grass and weeds grow near the sides of the channel, in which the propeller became fouled a number of times, causing unavoidable shut-downs. Two such mishaps on the way to Albany delayed the boat for from ten minutes to an hour each time, and the same difficulty was encountered, to a certain extent, on the return trip, preventing a strictly non-stop run. The results, however, even considering the shutting down and banking of fires, must be considered remarkable.

The summary of the trip is as follows:

July 9, 4.48 P. M., started from Hudson River Yacht Club dock.

July 10, 3:30 P. M., arrived first bridge at Albany.

July 10, 3:32 P. M., started for New York.

July 11, 10:15 A. M., arrived Hudson River Yacht Club dock.

Total mileage	275
Pounds coal burned to Albany	351
Pounds coal burned to New York	285
Total pounds coal burned for trip	636
Time to Albany	22 hours 42 minutes.
Time to New York	18 hours 43 minutes.
Time for entire trip	41 hours 25 minutes.
Pounds of coal burned per mile to Albany	2.55
Pounds of coal burned per mile to New York	2.07
Pounds of coal burned per mile entire trip	2.31
Pounds of coal burned per hour to Albany	15.45
Pounds of coal burned per hour to New York	15.20
Pounds of coal burned per hour entire trip	15.32

One of the principal objects in view when this boat was brought out was to demonstrate to the owners of coastwise schooners in the lumber, coal, and other trades, also to the owners of fishing boats, oyster boats, and owners of yachts requiring less than 500 horsepower, the fact that producer gas has many striking advantages over either steam or gasoline (petrol). A producer-gas plant can be installed on a fore-and-aft-rigged vessel at small expense, and can be operated at very slight cost. The cost of operation with anthracite coal costing about $4 (16 shillings) per ton, as shown by tests made on the motor boat *Marenging,* is practically one-tenth of what the cost would be if gasoline (petrol) were used at a cost of 15 cents (7½ pence) per gallon. As a matter of fact, gasoline (petrol) can seldom be bought at this price, and in many places it costs twice as much, so that the great economy of the producer-gas plant over a plant operated on gasoline (petrol) is evident.

As compared with a steam plant, the producer-gas plant, judging from the results obtained with *Marenging,* can show a decided increase in economy over a steam plant, since a horsepower an hour can be obtained on slightly over one pound of coal; whereas in the ordinary tugboat using high-pressure steam it is doubtful if a horsepower an hour is obtained on much less than 5 pounds of coal. On large steamships and warships a steam-power plant shows, of course, better economy than a tugboat, a horsepower an hour being obtained on an average of from 1¾ to 2 pounds of coal. A saving of from 25 to 50 percent in such plants, however, means a large sum of money.

Another advantage which should recommend this type of installation as an auxiliary in coastwise schooners and the like, is the ease of operation. Any man who can take proper care of an internal-combustion engine can, without any difficulty whatever, manage a producer-gas plant. It requires little, if any, more skill to manage such a plant than it does to manage an ordinary kitchen range.

MEASURED MILE TRIALS

The only way in which to determine the true speed of a vessel is to make a series of runs over a suitable measured mile. It, therefore, follows that measured mile trials must always be made where it is necessary to determine the speed of which a vessel is capable when developing her full or a given power at a given displacement, or to ascertain her radius of action at an economical speed; that is, the speed at which the vessel must travel to cover the greatest distance for a given total consumption of fuel. The results of such trials are also of the greatest importance in compiling data for future design work.

Great care is necessary in choosing and laying down a measured mile. The best mile is that which is sheltered, away from traffic, not affected by rapidly-flowing tides and of good depth of water. The posts marking the ends of the mile should be easily and distinctly visible from the vessel. The course should also follow the direction of the ebb and flow of the tide.

INFLUENCE OF THE TIDE.

The sources of error in running on the measured mile are many and various, but corrections may be made for some of them. The principal error is that due to the *influence of the tide.*

If the direction and flow of the tide were constant throughout the runs the arithmetic mean of a number of runs half with and half against the tide would give the true speed of the vessel. Unfortunately, the speed of the tide varies with the time, and the arithmetic mean, if used, will give a large error. For instance, the speed of the tide over a measured mile course at ten-minute intervals was .1, .33, .63, .85, 1.08 knots. If the true speed of a vessel were 20 knots, and a run was made each ten minutes, the first one with the tide, then the observed speeds for four runs would be:

First run....... 20.1
Second run..... 19.67
Third run...... 20.63
Fourth run..... 19.15

$$\text{Arithmetic mean} = \frac{79.55}{4}$$

Arithmetic mean = 19.8875

The error is therefore very nearly .12 knot. This error can be minimized by taking what is known as the *"mean of means."* If V is the true speed of the ship relative to still water, V_1, V_2, V_3, V_4, the speed of the tide at successive equal intervals of time; and, if the first run is assumed to be made with the tide, then the observed or apparent speeds would be

$$V + v_1, V \pm v_2, V + v_3, V \pm v_4.$$

In applying the mean of means the mean of the first two runs is taken, then that of the second and third, then of the third and fourth. These means are again meaned until only one mean is left.

The mean of means is thus

$$V + \frac{(v_1 - v_4) + 3(v_3 - v_2)}{8}$$

and the error is

$$\frac{(v_1 - v_4) + 3(v_3 - v_2)}{8}$$

The latter approaches zero, as may be demonstrated mathematically.

If S_1, S_2, S_3, S_4 are the observed speeds of the ship, the mean of means can be rapidly ascertained, as the process of meaning gives us

$$\frac{S_1 + 3S_2 + 3S_3 + S_4}{8}$$

as the "mean of means" speed.

For six runs we get in the same way:

$$\text{"Mean of means" speed} = \frac{S_1 + 5S_2 + 10S_3 + 10S_4 + 5S_5 + S_6}{32}$$

The mean of means process, applied to the example previously quoted of the 20-knot ship for four runs, gives:

	Observed Speeds.	Multipliers.	Functions for Speeds.
First run........	20.1	1	20.1
Second run......	19.67	3	59.01
Third run.......	20.63	3	61.89
Fourth run......	19.15	1	19.15
			8)160.15
		Calculated speed =	20.02

or an error of only one-sixth of that obtained by taking the arithmetic mean. If the first run had been against the tide the error would be the same, but with a different sign, and the speed would be 19.98 knots.

OBLIQUITY OF COURSE.

If the ship traveled on a course at an angle θ to the direction of the measured mile, the distance traveled from post to post would really be d sec θ (assuming that d represents the true length of the course). If T be the observed time of the run the true speed is

$$\frac{d \sec \theta}{T} = \frac{d}{T} + \frac{d}{T}(\sec \theta - 1)$$

= apparent speed + error.

It will be noted that, due to the obliquity of course, the true speed is *always* underestimated. For instance, if the time taken is four minutes and the obliquity be one point, the apparent speed over the mile is 15 knots and the true speed is $15 \times 1.0196 = 15.294$ knots (1.0196 being secant of the angle of obliquity).

INCORRECT FINDING AND SIGHTING.

When sighting the posts for alinement, the impression conveyed to the observer is that one post moves across the other. In order to avoid error it is necessary that the time should be taken at each end of the mile, as the posts appear to meet or separate. The distance between the posts equals the velocity of the ship times the time taken, or in symbols:

$$L = V \times T.$$

If V_1 is the true velocity of the ship corresponding to the actual time T_1, and V_2 is the velocity corresponding to an observed or incorrect time T_2, then $V_1 \times T_1 = V_2 \times T_2 =$ a constant, or

$$\frac{V_1}{V_2} = \frac{T_2}{T_1}$$

Assume that in a ship whose true velocity (V_1) is 20 knots, T_1 = three minutes. Suppose an error of two seconds be made in timing, then

$$T_2 = 3 \times 60 + 2,$$

and

$$\frac{20}{V_2} = \frac{3 \times 60 + 2}{3 \times 60}$$

or

$$V_2 = 19\ 7/9 \text{ knots.}$$

That is, an error of two seconds over the true time gives a decrease in speed of two-ninths of a knot.

ERROR DUE TO USE OF HELM.

It is usually necessary to use the helm in keeping a straight course on the mile, and use of helm means increased resistance and lessened speed. If tide and wind tend to carry the vessel across the mile it is advantageous to let the vessel take an oblique course, using only a small helm angle, and then correcting for obliquity of course. In a 25-knot vessel having a rudder area of 40 square feet, the indicated horsepower wasted with a helm angle of, say, one point may be as much as one-tenth of the total. This may be expressed as a loss of speed in the following manner, assuming that the indicated horsepower varies as the cube of the speed:

Denoting I. H. P. by I and speed by V.

$I \propto (V)^3$, or $I = KV^3$ (K being a constant).

$\therefore \log I = \log K + 3 \log V$.

$$\text{Differentiating } \frac{\delta I}{I} = \frac{3\,\delta V}{V}.$$

For a first approximation, δI may be taken to denote the loss of indicated horsepower due to helm angle, and δV the corresponding loss of speed. Hence substituting

$$\frac{1}{10} = \frac{3\,\delta V}{25}$$

or

$$\delta V = 5/6 \text{ of a knot.}$$

This shows how serious this error may become.

ERROR DUE TO ACCELERATION OVER THE MILE.

It is a matter of common knowledge that a vessel in motion through the water sets some of the surrounding water in motion, and some of it travels with the ship. Hence any acceleration of the ship means also acceleration of some of the surrounding water. It is, therefore, necessary that before the ship runs on the mile she should have traveled a sufficient distance to reach her full speed.

Mathematical expressions can be obtained for the space necessary to accelerate a vessel from a lower speed to a higher speed not her full speed. Theoretically, an infinite space is required to accelerate a ship to her full speed. If the resistance of a ship varies as the square of the speed, then the space in feet necessary to accelerate the vessel from a speed v_2 to a speed v_1, not her full speed, is theoretically

$$\frac{3}{5} \cdot \frac{W}{g\,R} V^2 \log_e \frac{V^2 - v_1^2}{V^2 - v_2^2},$$

the engines working at full power the whole time.

Here W = displacement of vessel in pounds,
g = acceleration due to gravity,
R = resistance of ship in pounds at full speed V,
V = full speed of ship.

it being also assumed that a mass of water of one-fifth of the displacement of the vessel is accelerated with the vessel. A similar but longer expression can be obtained in the same way where the resistance varies as the cube of the speed.

EFFECT OF SHALLOW WATER.

The effect of shallow water on the resistance and speed of a vessel has long been recognized. When a vessel runs in shallow water the wave formation usually suffers degradation, accompanied by an increase in the skin friction. The net effect of these alterations in the components of the total resistance may be such as to give either a greater or a less total resistance than the normal deep-water resistance. The researches of Rota and other experimenters clearly show that depths approximately given by $\frac{V^2}{60}$ should be avoided, the depth being expressed in fathoms and the speed, V, in knots, as this is the approximate depth at which an enormously increased resistance may be expected. However, Rota's results also show that depths of water well below this critical depth would give diminished resistance, and, therefore, an increased speed. In order, therefore, to get at the normal deep-water speed of the vessel it is important that the depth of water on the measured mile should not approach a depth in fathoms given by the above expression nor below this depth.

To thoroughly test a new vessel a full power trial of as long duration as possible is necessary, and the trial displacement should approximate that state of lading in which the vessel is most likely to be called upon to exercise her maximum speed. It is therefore usual in nearly all classes of vessels to stipulate:

1. A fixed period of time during which the maximum speed is to be maintained.
2. A particular lading during the trial.

The runs on the measured mile should then take place at the middle of the trial. The obvious procedure in commencing to run on the measured mile is to take up a course parallel to the posts, and at a sufficient distance from the first post to ensure no acceleration over the mile, and the minimum use of helm in maintaining the course when on the mile. The vessel is then timed between the posts by a chronograph, her exact course being also noted. The vessel is then taken round in a curve consistent with a minimum loss of way, and after getting up full speed again she is run back over the mile in the opposite direction, the chronograph again being used to obtain the time over the mile. It is necessary to make four, six, or even eight, runs over the mile in this way to obtain sensibly accurate results in eliminating tide effects.

Concurrently with the runs on the mile the revolutions of the screws are ascertained, and the revolutions per knot on the mile deduced. The total number of revolutions during the whole trial are also counted, and the full speed of the vessel during the trial thus determined.

MEASURED MILE TRIALS.

	Time of Run.	Knots	Revs. (Mean).	Multipliers.	Functions for Speed.	Functions for Revs.
Run No. 1.....	t_1	K_1	r_1	1	K_1	r_1
Run No. 2.....	t_2	K_2	r_2	5	$5K_2$	$5r_2$
Run No. 3.....	t_3	..	r_3	10	$10K_3$	$10r_3$
Run No. 4.....	t_4	..	..	10	$10K_4$	$10r_4$
Run No. 5.....	t_5	..	..	5	$5K_5$	$5r_5$
Run No. 6.....	t_6	K_6	r_6	1	K_6	r_6
					Σ_1	Σ_2

Then "mean of means" speed $= \frac{\Sigma_1}{32}$

Then "mean of means" revs. $= \frac{\Sigma_2}{32}$

Revolutions per knot $= \frac{\frac{\Sigma_2}{32} \times 60}{\frac{\Sigma_1}{32}} = \frac{\Sigma_2}{\Sigma_1} \times 60$

Supposing the the trial to last eight hours, the counters are recorded every hour, thus:

	Starboard Screw.	Port Screw.
End of 1st hour...........	S_1	P_1
End of 2d hour...........	S_2	P_2
:	:	:
:	:	:
:	:	:
End of 8th hour..........	S_8	P_8

Mean counters for eight hours $= \frac{S_8 + P_8}{2}$

$\therefore$ Knots in eight hours $= \frac{S_8 + P_8}{2 \times \text{revs. per knot}}$

$\therefore$ Mean speed $= \frac{S_8 + P_8}{2 \times \text{revs. per knot} \times 8.}$

$= \frac{S_8 + P_8}{16} \times \frac{E_1}{E_2 \times 60.}$

$= \frac{E_1(S_8 + P_8)}{E_2} \times \frac{1}{960}$ knots.

In carrying out such trials as have been described, it is essential to determine the power the shafts are transmitting, particularly in the case of vessels driven by turbines in which no estimate of the power corresponding to the indicated horsepower of a reciprocating engine can be made. These shaft horsepowers are most satisfactorily determined by the use of some form of suitable torsionmeter, and the readings should be made whenever the revolutions are taken.

J. R.

SOME MODEL EXPERIMENTS ON SUCTION OF VESSELS.*

BY NAVAL CONSTRUCTOR D. W. TAYLOR, U. S. N.

The question of the relative reactions of vessels under way and close to one another is one of great complication. That these reactions are strong is well known, and the cases of suction due to them when vessels have made ill-advised attempts to pass others too closely are well known.

Some experimental investigation of this question has been made at the model basin within the last year. The apparatus used was more or less of an improvised nature. It was found during the experiments that, as might be anticipated, there was more or less instability about the reactions involved, it being very hard to tow the models exactly straight, so that the results obtained cannot be regarded as highly accurate, but they show tendencies and the general nature of the phenomena very distinctly. Four models were used, all of 3,000 pounds displacement. Their dimensions, etc., are given below.

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* Read before the American Society of Naval Architects and Marine Engineers, June, 1909.

TABLE OF MODEL DIMENSIONS AND COEFFICIENTS.

Length of all on waterline......... 20.512 feet.
Length mean immersed............ 20.000 feet.
Displacement in fresh water....... 3,000 pounds.

Model Number.	B Beam, Feet.	H Draft, Feet.	$\frac{B}{H}$	Longitudinal Coefficient. l.	Midship Section Coefficient. m.	Block Coefficient. b.
834	3.692	1.263	2.92	.56	.90	.504
838	3.503	1.198	2.92	.56	1.00	.56
858	3.586	.957	3.75	.74	.926	.685
866	2.778	1.235	2.25	.74	.926	.685

These models were towed in pairs abreast one another or at definite distances ahead or astern. In the abreast positions they were towed at various distances apart. For other positions, the uniform distance apart of their center lines was 3.90 feet, or nineteen hundredths of the length of the model. While this is quite close, it should be remembered that these experiments were made in water many times the draft of the models, and hence the suction effects under given conditions would be less than if the water had been shallow, as is usually the case when suction phenomena are of importance in connection with actual ships.

The pulls or repulsions were measured at two points, near the bow and near the stern, as indicated in Figs. 3 and 4. It was found that within the limits of error the forces acting for a given relative location of the models varied with speed as the resistance of the model. This fact was taken advantage of to plot the forces in terms of the model resistance. This model resistance is that of the model when towed independently. The effect of the side suction upon resistance was not measured.

Figs. 1, 2, 3 and 4 show the results obtained. Fig. 1 shows the pulls and repulsions upon model 834 as it passes model 838. It also shows, for the position abreast, the reactions upon both models 834 and 838 for three spacings. Fig. 2 refers to models 858 and 866, showing the forces acting upon 858 as it passes 866. It also shows for the abreast position the model reactions for three spacings and the actions upon model 858 for greater distances apart. Fig. 3 shows curves of the pulls and repulsions upon model 834, corresponding to Fig. 1, and Fig. 4 shows the same for model 858, corresponding to Fig. 2. In Figs. 3 and 4 the zero position means that the centers of the two models are abreast one another. Their center lines were 3.9 feet apart, which was maintained throughout.

The position two-tenths ahead means that the center of model 834 is two-tenths of its length forward of the center of model 838, so that in the position five-tenths ahead the center of model 834 is abreast the bow of model 838, while in the position five-tenths astern the center of 834 is abreast the stern

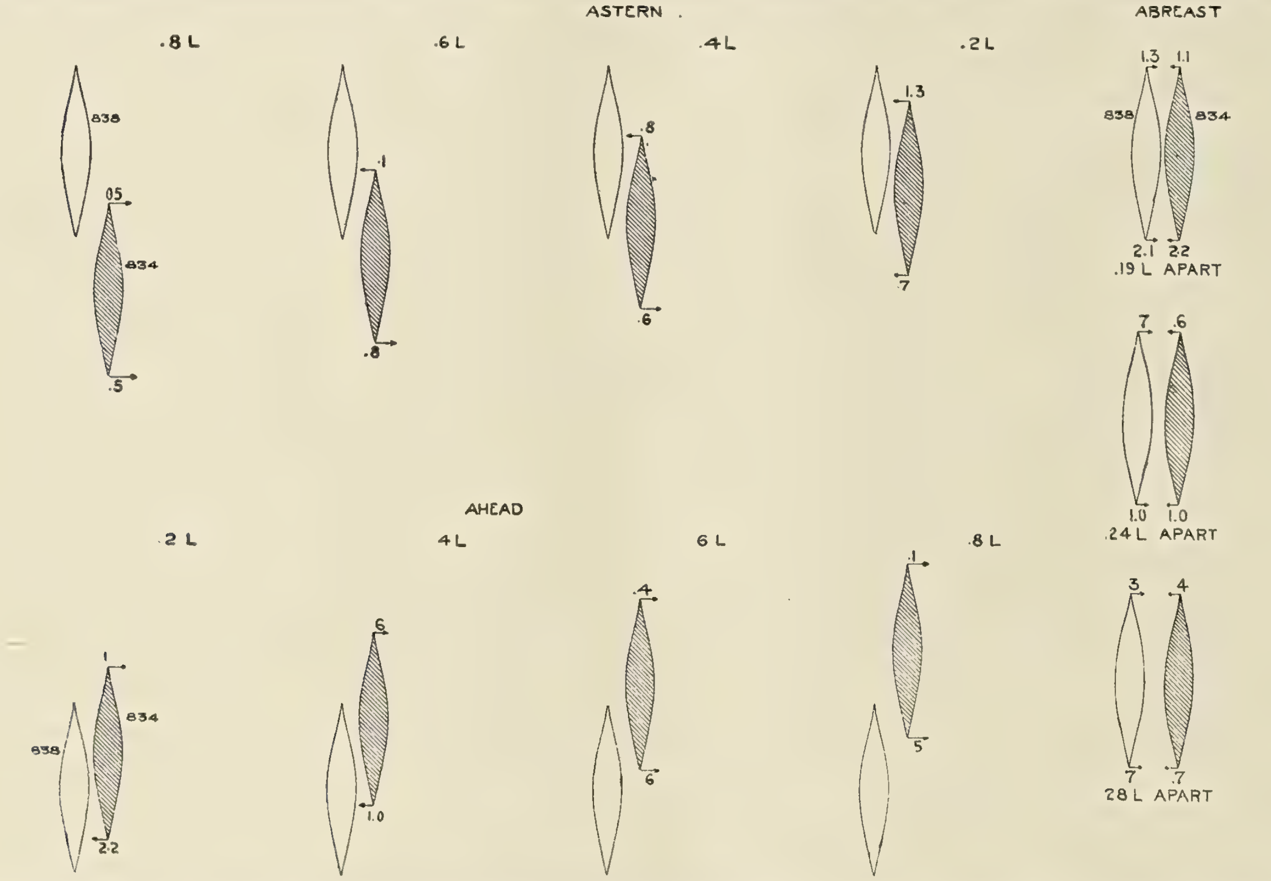

FIG. 1.—FORCES UPON MODEL 834 WHEN PASSING MODEL 838. THE ARROWS SHOW DIRECTIONS, THE FIGURES THE AMOUNTS EXPRESSED AS FRACTIONS OF THE TOTAL RESISTANCE.

of 838. It will be observed that models 834 and 838 were very similar, the main difference being that one had a finer midship section than the other, but both of them were of the fine type. Models 858 and 866 were similar in coefficients, etc., but 858 was broad and shallow, while 866 was narrow and deep.

The results obtained from the fine models were somewhat more consistent than those obtained from the full models, the latter being apparently more erratic. Broadly speaking, however, the results are in general accord and appear to indicate that when one vessel overtakes another on a parallel line, quite close to the latter, the sequence of phenomena is about as follows:

When the overtaking vessel just begins to overlap the other, there is little force acting. There appears to be a repulsion at both bow and stern, and, curiously enough, the repelling force upon the stern appears to be greater than that upon the bow. The resulting tendency is for the overtaking vessel to turn in toward the overtaken vessel. When partially overlapping, the tendency, as in the .6-L position in Figs. 1 and

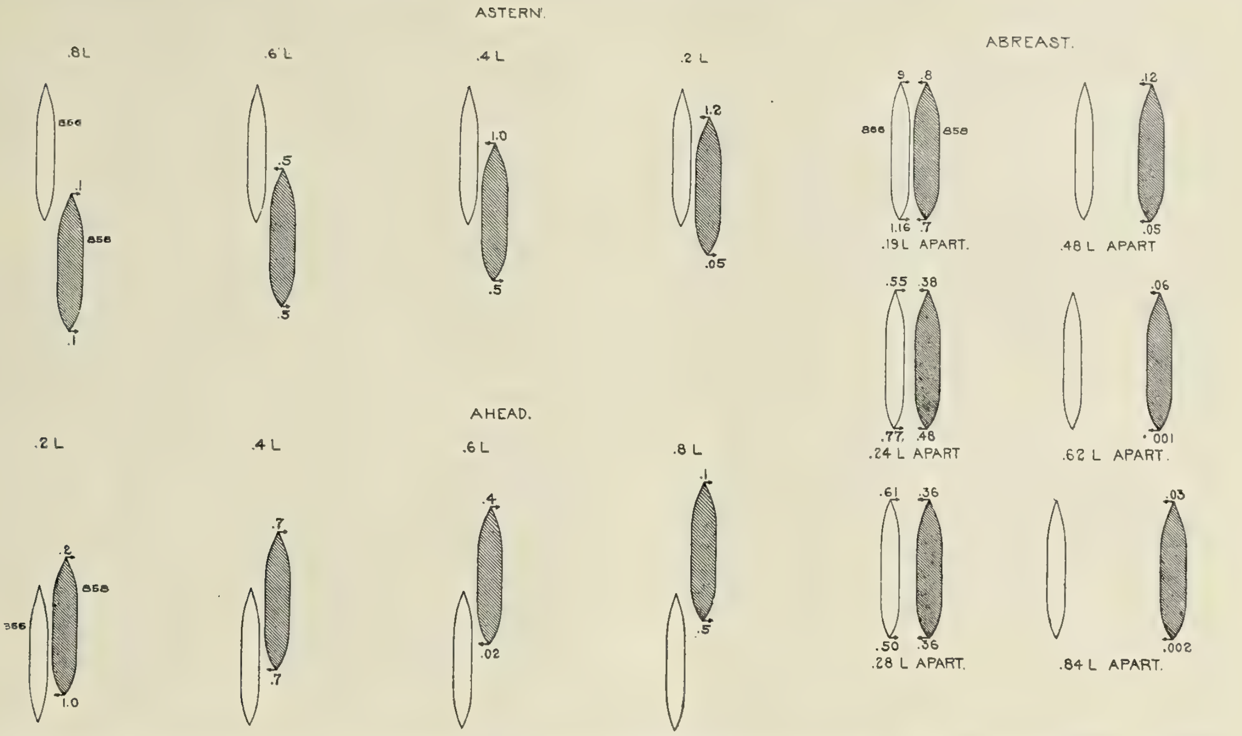

FIG. 2.—FORCES UPON MODEL 858 WHEN PASSING MODEL 866. THE ARROWS SHOW DIRECTIONS, THE FIGURES THE AMOUNTS EXPRESSED AS FRACTIONS OF THE TOTAL RESISTANCE.

2, is for the bow to be drawn in while the stern is still repelled.

As the overtaking vessel continues to pull up, the suction at the bow becomes stronger, and the repulsion of the stern falls off, until, as they come abreast, there is a rapid change in the stern force, which shifts from repulsion to strong suction.

As the overtaking vessel draws ahead, there is a reversal of conditions, the bow pull falling off rapidly and soon becoming a repulsion, while the stern pull becomes stronger, reaching its maximum when the center of the overtaking vessel is about two-tenths its length ahead the center of the overtaken vessel. It should be understood that the idea of the right-hand vessel overtaking the other is simply used for convenience in description. For given relative positions the forces upon the right-hand vessel would be the same whether overtaking or overtaken.

The figures illustrate the difficulties which are known to exist in avoiding collisions after certain positions are reached. Thus in Fig. 1 consider the position where the overtaking vessel is .4-*L* astern. There is here a strong tendency to swing the bow in toward the other vessel and cant the stern out. If the rudder is put to starboard, with the idea of throwing the bow out, the result will be either a diminution of the force at the stern which is pulling the stern to starboard, or its reversal, there being substituted for it a force which will push the stern to port. If the force is not reversed there will still be the tendency to swing the bow closer to the overtaken vessel. If the repulsive force is more than balanced we shall

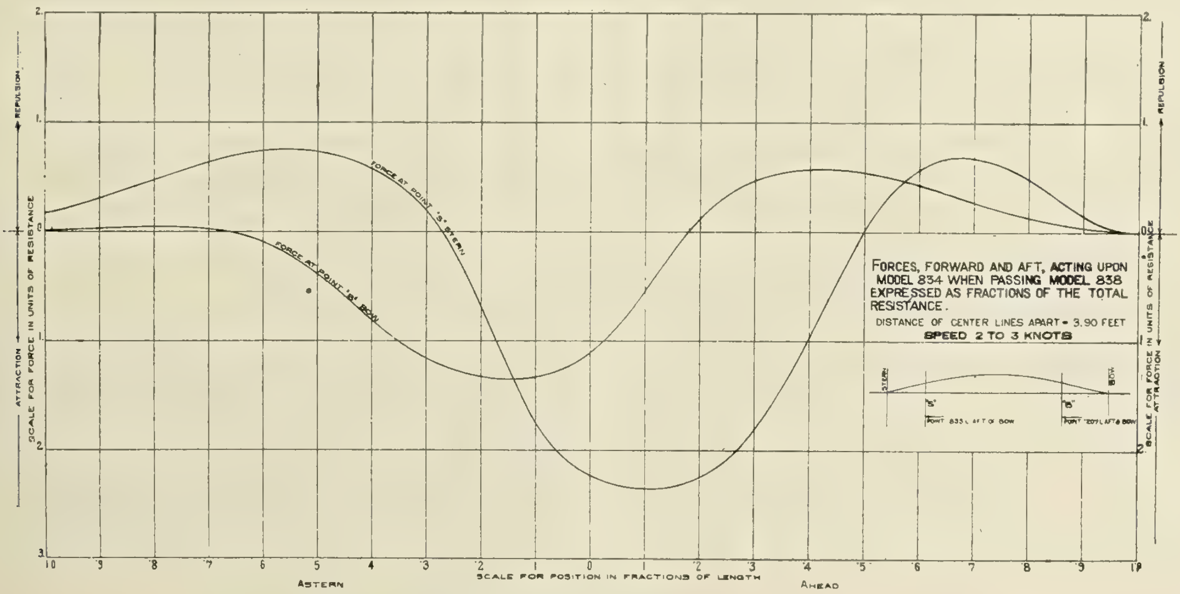

FIG. 3.

have both at bow and stern forces pulling the vessel bodily to port, and probably this will be sufficiently great to bring the vessels together regardless of the rudder action.

In the experiments the models were not allowed to obey the forces set up, being compelled to remain parallel to one another. In the case of a vessel actually overtaking another, the conditions would be different, since the vessel would always respond to the forces corresponding to its position, unless neutralized by the action of the rudder.

Fig. 2, showing the action upon model 858 when abreast of model 866 and at some distance from it, indicates that the forces involved fall off quite rapidly as the vessels get farther apart. The forces are, however, quite appreciable when the vessels are as much as one-third of their length apart.

In considering the application of these results to cases arising in practice it has already been pointed out that in practice vessels approaching one another closely are usually in shallow channels, where the forces may be expected to be greater than in deep water. Another difference is the fact that actual vessels are self-propelled, and it is frequently supposed that the suction of the propeller has much to do with the phenomena produced.

In this connection, however, it should be pointed out that we have some line upon what the suction of the propeller can do from our knowledge as to the thrust deduction on actual vessels. The thrust deduction of a vessel is simply the suction of its own propeller upon the after part. Now, except for very full single-screw vessels, the thrust deduction will seldom amount to as much as 20 percent of the resistance. This being the case, considering Figs. 1, 2, 3 and 4, it is difficult to see how the suction of the propeller upon the vessel at an appreciable distance can be as much as 4 or 5 percent of the propeller thrust or the resistance, while the forces found from the bare model reactions are very much larger. This, of course, does not apply to the wash from the propeller, but the wash is restricted to a comparatively narrow belt immediately astern, and hence cannot be said to play an important part in suction phenomena.

In conclusion, I desire to record that the experiments upon which this paper is based were carried out under the direct charge of Mr. L. F. Hewins, assisted by Mr. George Thorne, both of the model basin staff.

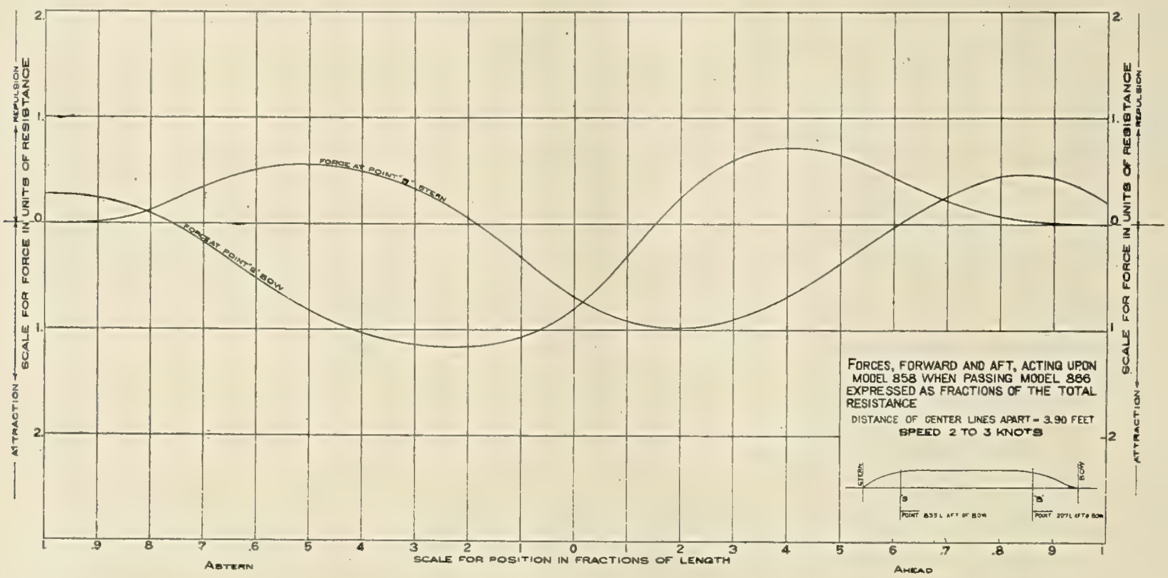

FIG. 4.

The Canadian Government's Unfortunate Experience with Acetylene Buoy Lighting.

The illustrations show some of the difficulties recently encountered by the Canadian Government in its endeavor to utilize acetylene gas for buoy lighting. Fig. 1 was taken after the explosion of a compressed acetylene gas buoy on a dock at Kingston, Ont. The steamer *Scout* was lying alongside the dock, charging the buoys, when one already filled, without warning, exploded, killing four men. This accident cost the Canadian Government over $40,000.

FIG. 1.

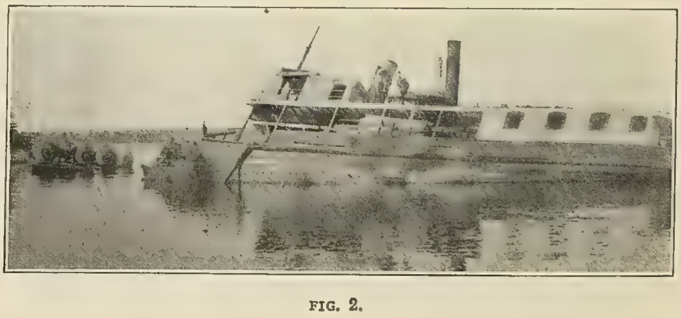

FIG. 2.

Fig. 2 shows the steamer *Pilot* sunk by the explosion of a compressed acetylene buoy, which was being filled while in the water, from charged steel holders on the deck of a scow. One man lost his life in this accident, and the damages have not yet been assessed. The accident occurred near Parry Sound, Ont.

Fig. 4 shows a Willson low-pressure gas buoy on the dock at Halifax, N. S. This buoy exploded while in tow of the Government steamer *Lady Laurier*. The buoy was towed over on its side, and the action of water on the mass of carbide caused the accident.

FIG. 3.

Frequent minor explosions have occurred with this type of buoy, and several men have been maimed and one recently killed in Quebec. It would appear necessary to utilize some safety devices if acetylene must be used.

FIG. 4.

THE RESISTANCE OF SOME FULL TYPES OF VESSELS.*

BY PROF. HERBERT C. SADLER.

It may be thought that vessels having a block coefficient of from .80 to .86 and a prismatic coefficient of from .83 to .89 do not offer much opportunity for appreciable variation of form under given conditions as to dimensions. It may also be questioned if such changes as are possible will produce a marked effect upon the resistance or indicated horsepower, because, at the speeds common in vessels of this type, the surface friction represents the principal part of the resistance. The problem, in a somewhat different form, is constantly arising in practice, and is generally one where additional carrying capacity is required upon limited dimensions without appreciable addition to the horsepower, the speed remaining constant. Although the subject has not been investigated to its

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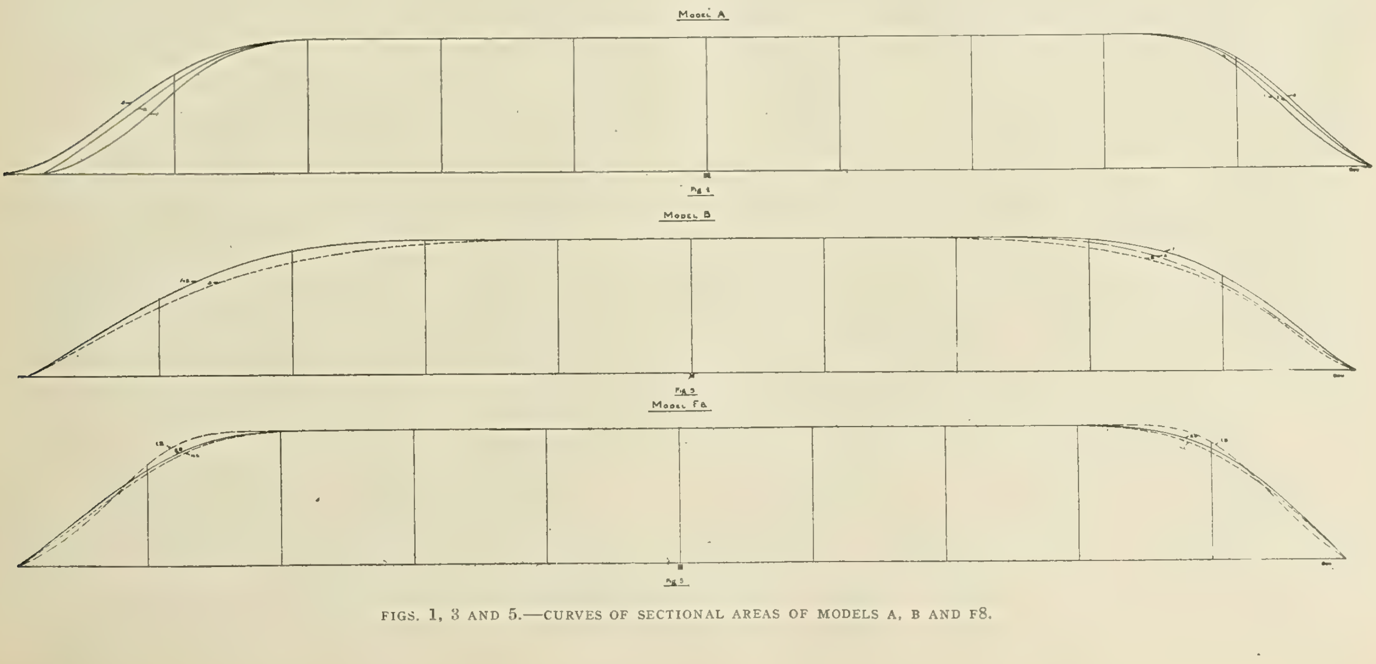

FIGS. 1, 3 AND 5.—CURVES OF SECTIONAL AREAS OF MODELS A, B AND F8.

fullest extent, the results given below show the possibilities of improvement in the form of vessels of this type, and also give a certain amount of data which may be useful.

Figs. 1 and 1*a* show the curves of sectional areas and the body plan of a wide and shallow type with the following coefficients:

$\frac{L}{B}$	4.35	4.35	4.35
$\frac{B}{d}$	6.17	4.625	3.7
Block coefficient	.822	.845	.858
Prismatic coefficient	.839	.858	.870
Midship-section coefficient	.98	.985	.986

The model was tried at three drafts, and the curves of residuary resistance per ton of displacement are shown in Fig. 2. At the deepest draft the counter was partially immersed in still water, but as this also happened at the lesser

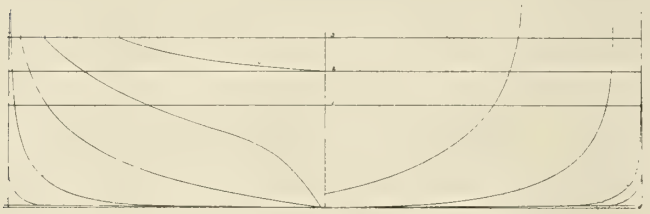

FIG. 1a.—MODEL A.

drafts when the model attained moderate speeds, the conditions are practically similar. Time did not permit any modifications in this form, which, as will be seen, is of a ship-shape character; but, in all probability, as good, if not better, results might have been obtained by adopting a more typical "scow" form, especially at the speeds usual for this type.

The body plans and sectional area curves of the next series to which attention is called are shown on Figs. 3 and 3*a*. In this series certain modifications of form were made which consisted mainly in fining the lower part of the sections at some distance from the bow, and also easing the form where the fore body joined the parallel midship body. The displacement, therefore, varies for each modification, as shown in the following table:

	I.	II.	III.
$\frac{L}{B}$	5.81	5.81	5.81
$\frac{B}{d}$	3.0	3.0	3.0
Block coefficient	.814	.804	.782
Prismatic coefficient	.831	.821	.798
Midship-section coefficient	.980	.980	.980

The curves of residuary resistance are shown in Fig. 4. The effect of even a slight modification of form is seen by comparing curves 1 and 2. For a reduction of displacement of 1.25 percent there is a corresponding reduction of about 10 percent in residuary resistance at speed-length ratios of between .60 and .70. In the case of a 300-foot ship this would mean a reduction of about 100 indicated horsepower, at a speed of nearly 10.5 knots. The effect of a still further reduction is seen by comparing curves 1 and 3, and in this case the saving would amount to nearly 300 indicated horsepower at the above speed. In both the above cases it should be remembered that, although the displacement is decreased, there is a corresponding decrease in weight of machinery and coal, and the balance, from a commercial standpoint, might sometimes be in favor of the finer vessel.

Attention is also called to the fact that, although the residuary resistance per ton of displacement shows somewhat small differences, the displacement also decreases, and hence

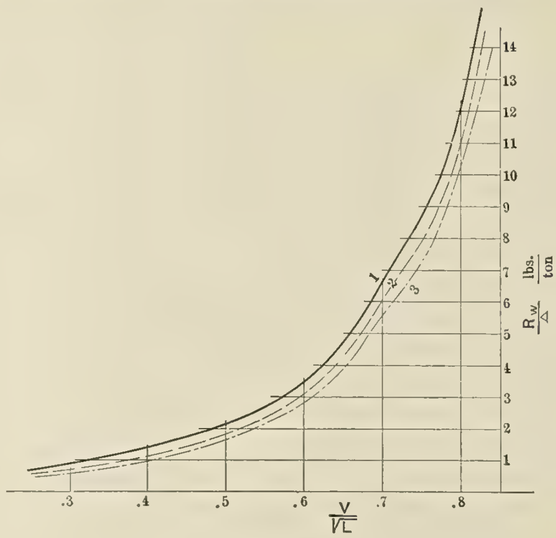

FIG. 2.—MODEL A.

the reduction is greater than appears from the curves. The wetted surface also is slightly decreased.

The next series represents a narrower type and one approaching more nearly the ordinary lake freighter. The body plan and sectional area curves are shown in Figs. 5 and 5*a*. The particulars of the model are as follows:

$$\frac{L}{B} = 8. \qquad \frac{B}{d} = 2.143.$$

Block coefficient = .855.
Prismatic coefficient = .869.
Midship-section coefficient = .984.

The forms 1*B*.1*S* and 2*B*.2*S* are taken from the paper read last year, and call for no further comment. They are added

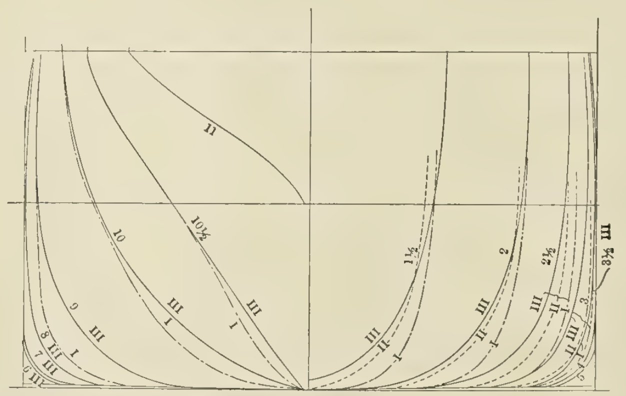

FIG. 3a.—MODEL B.

for the sake of comparison, with further modifications of the better of the two forms, viz.: 2*B*.2*S*.

The modifications in general are shown by the hatched portions on the body plan. First. The lower parts of the bow sections were reduced. Second. The same thing was done with the after sections. Third. The amount cut from below was added to the upper part of the bow sections, thus bringing

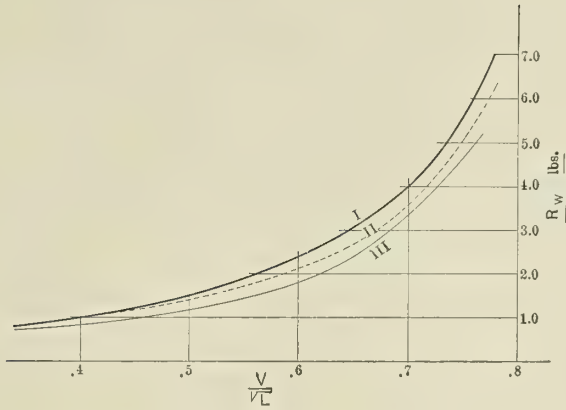

FIG. 4.

the fore body back to the original displacement. Fourth. The same thing was done with the stern sections. In this case the maximum reduction in displacement, when both bow and stern sections were reduced, amounted to about .64 percent of the total displacement, and in the final modifications (4) the displacement is the same as the original.

The results of the various modifications are shown in Fig. 6, and marked *m*1, *m*2, *m*3, *m*4. Cutting away the lower part of the bow sections made a considerable reduction in resistance, and a similar effect was obtained with the modified stern. When the bow sections were brought back to their original areas by adding area above, little or no difference was detected in the residuary resistance per ton of displacement. With the sectional area finally the same as the original *2B.2S*, but with the sections of the vessels modified by cutting away

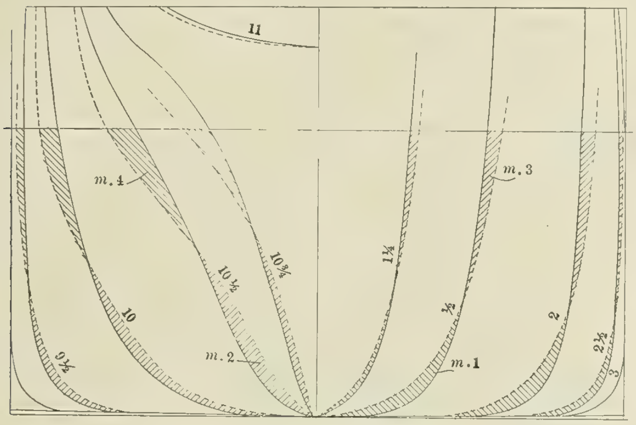

FIG. 5a.—MODEL F8 WITH MODIFICATIONS.

the lower part and filling out above, the residuary resistance was slightly increased, as shown in curve *m*4. A comparison of this curve with the original shows a considerable saving, while compared with the form *1B.1S*, the residuary resistance has been reduced nearly 50 percent.

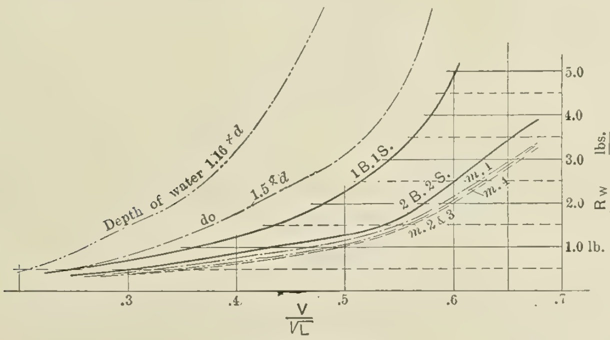

FIG. 6.—MODEL F8.

As a matter of interest, curves of residuary resistance have been added for shallow water. A complete series at varying depths is under investigation for this and other types, but is not yet completed. The two curves given correspond in depth of water 1.166 and 1.5 times the draft of the vessel. In the shallow water the model was run until it touched bottom, and in the deeper water until the resistance increased abnormally. The rapid rise in residuary resistance is most marked.

In conclusion, it may be observed that even in full slow-speed vessels it is possible to effect a saving in power by proper adjustment of form to the conditions demanded. An analysis of the above results indicates that it is advantageous to keep the waterline of vessels of this type rather full at both ends, and to have the waterline near the bilge as easy as possible. In other words, easy buttocks at each end appear to give better results than those of a somewhat full form below and fine above.

The Car-Ferry Michigan Damaged by Collision.

The Canadian Pacific car ferry *Michigan,* carrying a freight train across the Detroit River from the Windsor terminals to the railroad yards on the Detroit side, was struck recently, and her superstructure on the starboard side partially demolished, by the large steel freighter *James P. Walsh.* The *Walsh,* which is 489 feet long, was loaded with coal and upward bound. The *Michigan* is of the paddle-wheel type, and her starboard wheel, by taking the brunt of the collision, saved

EFFECT OF BROADSIDE COLLISION ON CAR-FERRY MICHIGAN.

the steel hull from being pierced by the sharp brow of the freighter.

The blades of the wheel, which at the time of the shock were on the afterside and moving upwards, were demolished, and the shaft displaced. The deck above projected out over the hull, and the resistance offered by it to the destructive force of the collision prevented the hull from being damaged.

Immediately after they came together the *Walsh* backed away and stood by, while the *Michigan,* with her engines disabled, drifted down stream. Aided by two tugs and a stiff up-stream wind, the tugs worked the ferry back to the Canadian side and docked her. The *Walsh,* showing but little damage, crossed the river for examination. The examination showed the freighter to be sound and practically uninjured. Since all the damage to the *Michigan* was above the waterline and the hull sound she did not require docking for repairs.

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Hudson-Fulton Memorial Issue.

The September number of International Marine Engineering will be a special historical number in commemoration of the tercentenary of the discovery of the Hudson River and the centenary of the first navigation of the river by steamboat. The entire number will be devoted to a complete history of naval architecture and marine engineering, from the earliest types of boats of which there is any record down to the present-day steam and sailing vessels. It is our aim to make this issue a standard historical work, covering the subject in a complete and exhaustive manner. For this reason most of the regular matter will be omitted from this issue and the next installment of all continued articles will appear in October.

Practical Results with a Marine Producer-Gas Plant.

We have frequently referred in these columns to the desirability of using producer-gas power for small marine installations and as auxiliary power in large sailing vessels. This form of power is now well beyond the experimental stage, and sufficient data from actual plants are at hand to give a basis of sound judgment as to its economy and reliability. It cannot be claimed that producer gas is today available for vessels requiring large power simply because the largest marine gas engine which has so far been built is of only about 500 horsepower. The possibilities in this direction, however, are boundless, and we feel confident that rapid strides will be made in the near future in the development of large-sized gas engines suitable for marine work.

Considering only the installations which are practically available to-day, we find producer gas in extensive use in Germany and Holland on barges, canal boats, and small vessels plying on the rivers and lakes. These boats are all well beyond the experimental stage and are mostly of small horsepower. Development in this direction in England and the United States has been limited practically to manufacturers' tests and some experiments by the Admiralty. A few months ago, however, the publisher of this journal brought out the 40-foot motor boat *Marenging* equipped with a producer-gas plant for the purposes of independent experimental investigation. Some of the more important results obtained with this plant and the conclusions to be drawn from them appear elsewhere in this issue.

Perhaps the two most important things which have been proved by experience with this plant are the reliability and economy of marine producer-gas installations. At no time has there been any evidence of unexpected breakdowns or serious trouble with any part of the plant. It has proved to be even more reliable than a first-class steam plant or a well-designed oil engine. More power might have been obtained if it had been possible to get better compression in the engine. While this is in no sense a reflection on the design of the engine, which was originally intended for gasoline (petrol), yet it shows that some care must be used in the adaptation of the engine to get the best results from producer gas. As to economy, an average of slightly over one pound of coal per horsepower per hour must be considered a remarkable performance for a marine power plant. With a larger plant it is probable that even better results could be obtained. As compared with a gasoline (petrol) engine there is a saving of between 80 and 90 percent in the cost of operation, and as compared with a steam power plant a saving of between 25 and 50 percent.

Coupled with this remarkable economy and reliability, such a plant presents a number of other striking advantages. It is easy to operate and plants of large

size would require only a comparatively small force of attendants. Suitable fuel is readily available at any port, and there is absolutely no danger of explosions from the presence of gas leakage, fires or similar mishaps. Fresh water is not required for the operation of the producer, and a marked saving in the weight and space occupied by the entire installation can be obtained as compared with a steam plant of the same size. Taking everything into consideration, this plant has demonstrated, to the satisfaction of the owner and many naval architects and marine engineers who have observed its performance, the great value of this form of propulsion.

Further Scout Cruiser Trials.

A recent voyage of the three United States scout cruisers *Chester, Birmingham* and *Salem* from Madeira to Boston, at cruising speed, has given an opportunity for further comparison of the performance of these three vessels. It will be recalled that the hulls of all three ships are identical, but the type of power plant is different in each case. The *Birmingham* is driven by twin screws, with reciprocating engines; the *Salem* by twin screws with Curtis turbines, and the *Chester* by four screws, with Parsons turbines. The designed horsepower in each case was 16,000. The daily coal reports of the three vessels on the run from Madeira to Boston were as follows:

Date.	Average Speed, Knots.	Tons of Coal. *Salem.*	*Chester.*	*Birmigham.*
June 24	13.4	84	110	93
June 25.......	13.4	92	101	104
June 26.......	13.8	96	137	111
June 27.......	13.7	94	144	111
June 28.......	13.1	95	137	113
Totals ...		461	629	532
Daily average.	13.48	92	126	106

During this run the *Salem* showed by far the best economy in coal consumption, averaging 14.2 tons of coal less than the *Birmingham* daily and 33.6 tons less than the *Chester*. The propellers of all three ships had been cleaned before starting and all ships had been out of dock for the same length of time. It is probable, however, that the *Birmingham* and *Chester* were a little more foul than the *Salem,* as they had been lying in tropical waters for some time. Each vessel was supplied with practically the same quality of coal and, of course, the weather conditions were identical. All the conditions, in fact, were apparently favorable for a competitive trial of the three vessels, and it was to be expected that the results of the voyage would show in some measure the relative merits of the three modes of propulsion.

The results, however, in the light of the previous competitive trials of these vessels, were surprising. The coal consumption of the *Salem* practically agreed with the results obtained on the recent competitive trials when she was outdone in both these respects by the other two ships. It will be remembered that during the competitive trials it was found that the *Salem's* starboard turbine was damaged, and since this has subsequently been overhauled it was to be expected that the ship would show slightly better results in coal consumption. More surprising than its failure to do this, however, is the fact that both the *Chester* and *Birmingham* showed a marked decrease in economy as compared with their previous official and competitive trials. Both ships were making revolutions corresponding to about 15 knots speed on the standardization curves, whereas the actual average speed of the vessels was 13.48 knots. By reference to page 389 of the September, 1908, issue of International Marine Engineering, it will be seen that on the standardization runs at 15 knots the *Birmingham* burned 73 tons of coal and the *Chester* 85. The power required and the steam used for this number of revolutions might be expected to be slightly more in this case than shown on the standardization curves, but the increase in coal consumption for the revolutions corresponding to 15 knots is, however, abnormal. Whether this was due entirely to the foul condition of the bottoms of the vessels or whether it was due to poor condition of the machinery is necessarily a matter of conjecture in view of the lack of more detailed information.

One thing is apparent, however, and that is that so far the comparative trials of these three vessels have been disappointing and they have failed to establish, with the desired certainty, which type of machinery is best adapted for marine propulsion. It is to be hoped that before long more satisfactory results will be obtained with these vessels.

Indicators.

A great many books have been published on the subject of the steam-engine indicator, and as this instrument was invented almost as long ago as the steam engine itself, it would hardly seem that there is much that is new to be said regarding the subject. If every marine engineer were thoroughly conversant with the volumes which have been published on indicators we would, indeed, have little excuse for again bringing up the subject, but there is ample evidence to show that the average marine engineer still has much to learn about this important instrument. We, therefore, invite attention to a valuable series of articles dealing with the practical use of the marine steam-engine indicator, publication of which was begun in our July issue. The indicator is not, and never can be, a perfect instrument, but in the hands of an expert it can produce results with a very good degree of precision. Unless one understands thoroughly, however, the limitations of the indicator he is apt to fall into very serious errors of judgment.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		June 1.	July 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons.........	92.3	94.6
Michigan ...	16,000	18½	New York Shipbuilding Co..	98.1	98.3
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	82.4	86.9
North Dakota	20,000	21	Fore River Shipbuilding Co..	84.8	87.7
Florida	20,000	20¾	Navy Yard, New York.......	16.4	19.9
Utah	20,000	20¾	New York Shipbuilding Co...	20.0	26.8
TORPEDO-BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons.........	88.4	94.6
Lamson	700	28	Wm. Cramp & Sons.........	80.5	84.9
Preston	700	28	New York Shipbuilding Co..	77.4	82.2
Flusser	700	28	Bath Iron Works	74.0	83.6
Reid	700	28	Bath Iron Works	73.0	79.8
Paulding ...	742	29½	Bath Iron Works	14.2	17.6
Drayton	742	29½	Bath Iron Works	14.2	17.6
Roe	742	29½	Newp't News Shipbuilding Co.	46.7	51.6
Terry	742	29½	Newp't News Shipbuilding Co.	41.0	47.6
Perkins	742	29½	Fore River Shipbuilding Co..	28.3	37.9
Sterrett	742	29½	Fore River Shipbuilding Co..	28.3	35.8
McCall	742	29½	New York Shipbuilding Co..	13.1	17.1
Burrows	742	29½	New York Shipbuilding Co..	12.8	16.7
Warrington..	742	29½	Wm. Cramp & Sons.........	19.6	23.9
Mayrant	742	29½	Wm. Cramp & Sons.........	23.4	30.0
SUBMARINE TORPEDO BOATS.					
Stingray	...	..	Fore River Shipbuilding Co..	91.7	94.3
Tarpon	...	..	Fore River Shipbuilding Co..	91.7	94.3
Bonita	...	..	Fore River Shipbuilding Co..	85.2	87.3
Snapper	...	..	Fore River Shipbuilding Co...	84.9	87.1
Narwhal ...	...	..	Fore River Shipbuilding Co..	91.6	93.7
Grayling ...	...	..	Fore River Shipbuilding Co..	88.8	90.1
Salmon	...	..	Fore River Shipbuilding Co..	81.0	81.1
Seal	...	..	Newp't News Shipbuilding Co.	18.0	20.4
Pickerel			The Moran Co..............	0.0	3.1
Skate			The Moran Co..............	0.0	3.2

ENGINEERING SPECIALTIES.

The Terry Steam Turbine.

The designer of the Terry steam turbine, which is manufactured by the Terry Steam Turbine Company, Hartford, Conn., and New York City, had in mind two essential features: first, to produce an efficient, small, low-speed machine, and, second, to make one of the very simplest design. The unusual low speed of the Terry turbine permits direct connection without the attendant troubles, at the same time eliminating gears, while simplicity means successful operation and but few parts, all easy to inspect.

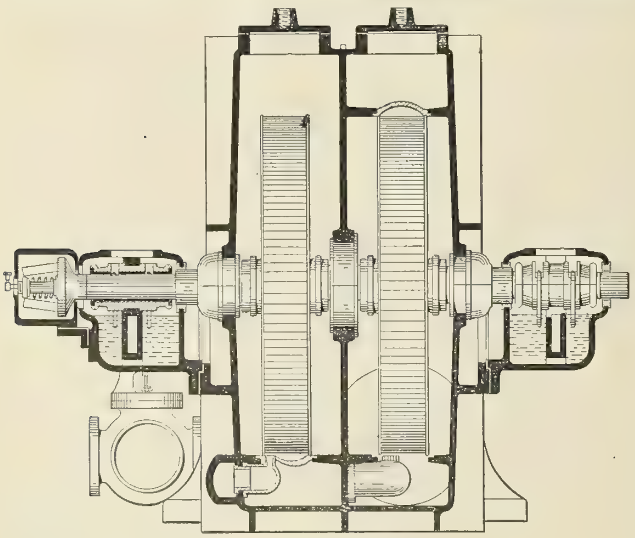


FIG 1.

The turbine is of the compound velocity stage impulse type; that is, the steam is practically wholly expanded in a correctly-formed jet or nozzle, wherein the static pressure of the steam is converted into velocity energy. This energy is delivered to the wheel as useful work in the following manner: The wheel is fitted with semi-circular buckets. The steam escaping from the jet strikes one side of this bucket, and is reversed in direction, leaving the opposite side of the same bucket; then it enters the first stationary bucket or reversing chamber. This chamber redirects the steam back again into another bucket of the same wheel at a point adjacent to the jet. This operation is repeated as many times as necessary for the complete utilization of all the available energy in the steam, its velocity being extracted successively in each reversal or stage. As the flow of steam into and from the buckets is at all times in a plane normal to the shaft, there is, therefore, no thrust regardless of initial pressure or vacuum. Increased power for a wheel of a given diameter is obtained by fitting additional jets and reversing chambers in the casing, each jet, of course, being supplied with live steam. When partial load is to be carried one or more of these jets may be turned off by hand-operated valves to give full-load efficiency. Thus all the advantages due to the increased economy of the multiple-wheel turbine are obtained, with the obvious mechanical advantages of the single-wheel turbine. Furthermore, as the steam is expanded in the nozzle the turbine casing and wheel are not subjected to high pressures or superheat, such as are effectively employed to improve the efficiency, but only to those corresponding to the exhaust pressure. Thus radiation losses are reduced to a minimum.

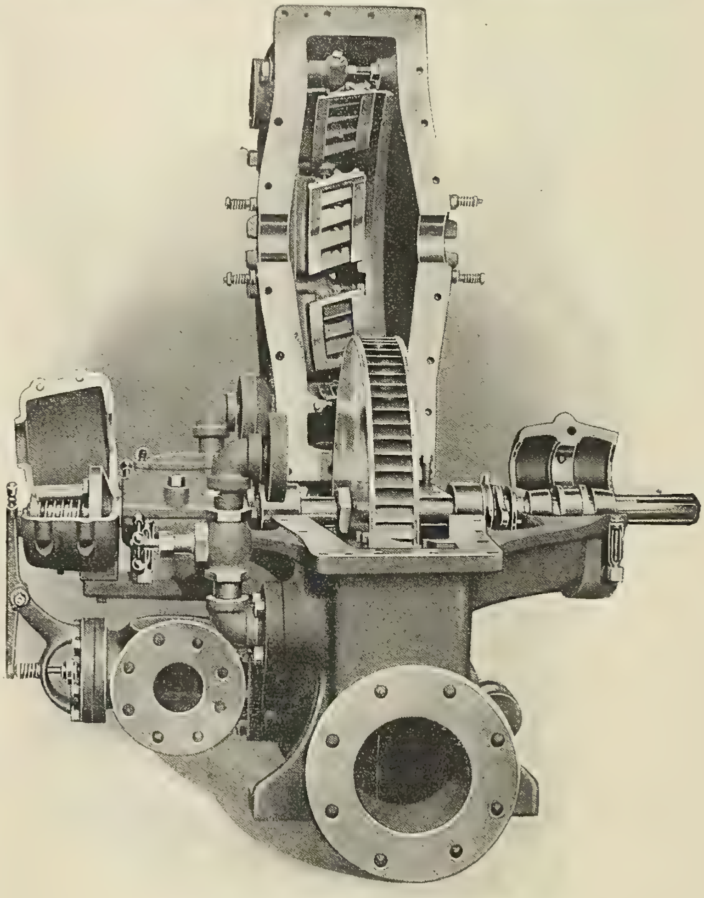


FIG. 2.

The casing and bearings are parted horizontally, so that by lifting the covers the entire turbine is open for inspection. The wheel and shaft are of steel, perfectly balanced and tested to safely withstand a speed 50 percent above rating. Clearances between the wheel and reversing chambers are ample. Because of the low temperature of the jet of steam, there is but slight difference between the clearance when the

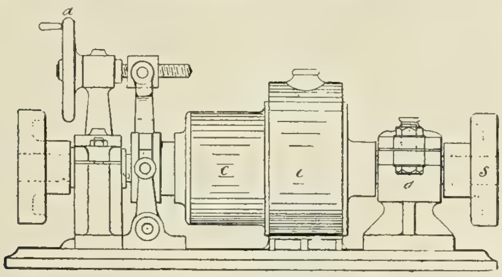
turbine is cold or when it is running. The stuffing-boxes in the casing are of special construction, with ground metal seats, allowing free movement of the shaft while maintaining a tight joint without the use of soft packing. The governor is of the fly-ball type, mounted directly on the turbine shaft, controlling a specially-constructed miter throttle valve. As no gearing is employed the necessity of an emergency governor is so slight that none is fitted in the standard design. Furthermore, should the main governor spring break the governor valve would instantly close. A maximum speed variation of 2 percent is guaranteed when desired. Ring lubrication is employed for all main bearings. The small load on the bearings, due to the light weight of rotor, and the slow surface speed, due to the low speed of revolutions, bring these bearings well within the safe limits for ring oil bearings. The bearings are supported by brackets from the turbine casing. In the smaller sizes they are made in one piece of best grade phosphor bronze, while in the large sizes they have a bearing shell lined with Babbitt metal.

For condensing service the two-stage turbine is used for all except the smaller sizes, where the single stage is supplied. After the steam is passed through the high-pressure stage it enters the second stage through nozzles and reversing chambers, arranged similarly to those in the first stage. As illustrated in the sectional view, the distance between the bearings of this turbine is so small that troubles, due to whipping of shaft, etc., are negligible.

This turbine has been extensively used on battleships, destroyers, yachts and merchant vessels for driving centrifugal pumps for boiler feed or circulating service, for forced draft fans and for generators. Low-pressure turbines to utilize the exhaust steam from non-condensing engines may also be effectively installed.

A Coil Clutch for a Marine Reversing Gear.

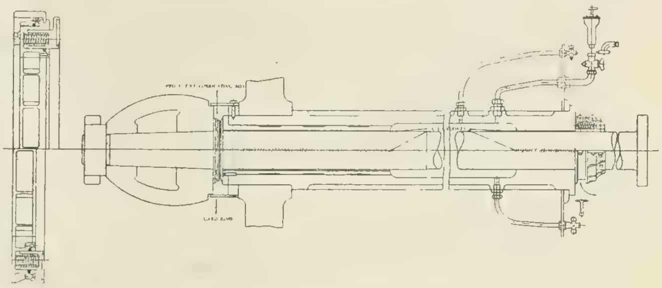
The Coil Clutch Company, Ltd., Johnstone, Scotland, has for many years been manufacturing coil clutches capable of transmitting large powers, and recently a clutch for reversing propellers has been developed on the same principles. The principle of the coil clutch is the same as that of an ordinary capstan, where, after a sufficient number of turns of rope is taken around the capstan, the friction becomes great enough for the rope to grip; similarly in the coil clutch a mild steel coil, the interior circumference of which is turned smooth



and highly polished, is fitted over a chilled, cast iron drum, the surface of which is also ground to a polish. One end of the coil is always fixed to the driving plate, while the other end is free to move. Winding up the coil slightly decreases its internal diameter, causing it to grip the drum and transmitting the power through it. The illustration shows a diagrammatic sketch of the marine reversing gear. C and C' are the clutch and gear cases containing lubrication; D is a combined ball-bearing and thrust block, while S is the driving shaft carrying the propeller. The gear is always in mesh, and only comes into action when the propeller is reversed, consequently this clutch is perfectly silent when running ahead, and it is claimed that it is almost noiseless when going astern. There is one positive speed ahead and astern, both controlled by the hand-wheel *a*. These reversing clutches for marine work are now being manufactured in sizes up to 500 horsepower, although similar clutches for controlling armor-plate rolling mills have been built transmitting as high as 6,000 horsepower.

An Adjustable Protective Lubricating Box for Propeller Tail=Shafts.

The ordinary water-lubricated stern-tube bearings, such as are generally used on steamships, have many disadvantages which might be overcome. In the first place, the lubrication of both bearings in the stern tube is poor. Water and injurious matter are likely to destroy the stern tube. Costly brass sleeves and lignum vitæ bearings are necessary, and galvanic action is usually fairly active, tending to destroy the bearings. An adjustable protective lubricating box is being manufactured by F. R. Cedervall & Söner, Göteborg, Sweden, which is designed to overcome these disadvantages. The device consists of a protective lubricating box, placed between the forward face of the propeller boss or hub and the after face of



the stern tube. A guard ring encircles the box to protect it from damage. The box itself is attached to the forward face of the propeller hub, and turns with it, so the forward face of the box is pressed outward and against a prepared surface at the after end of the stern tube by spiral springs, as shown in the illustration. This makes a water-tight joint, preventing the entry of water into the stern tube, and, if desired, a pressure of oil may be maintained inside the tube that will exceed the external pressure due to the water, so that the oil will tend to work outward, lubricating the surfaces on its way. This apparatus obviates the necessity of expensive casings and bearings, as a plain cast iron tube is all that is required. Since dirt, sand, grit and water cannot get into the box, and since the bearings are thoroughly lubricated, a marked increase in the life and efficiency of the stern bearings is claimed.

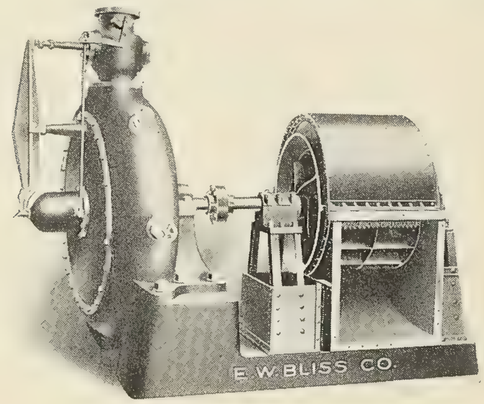
Cane Furniture for Ships.

Substantial cane furniture offers many advantages for ship use. The older cane goods were so carelessly and flimsily made, with tacked-on plaits and borders, that continual trouble was experienced by users from torn clothes and unwrapping, as well as the unpleasant squeaking and general unsubstantial nature of the article. Dryad furniture, which is manufactured by Harry H. Peach, Leicester, by a skilfull adaption of bend wood and a soundly-constructed frame, is a furniture which will stand an enormous amount of rough usage, while the close weaving, careful finish, avoiding all tacked-on or plaited work, together with a careful shaping, give a comfort only comparable with upholstered goods. The fact that natural pulp can can be easily washed is a great advantage, on the score of cleanliness and the lightness of cane, as compared with the clumsier wooden upholstered furniture, while practically the same comfort is given, is a great advantage for ship use. In design Dryad furniture is particularly pleasing, being based on sound construction and careful study of the best old English furniture.

The Bliss Steam Turbine.

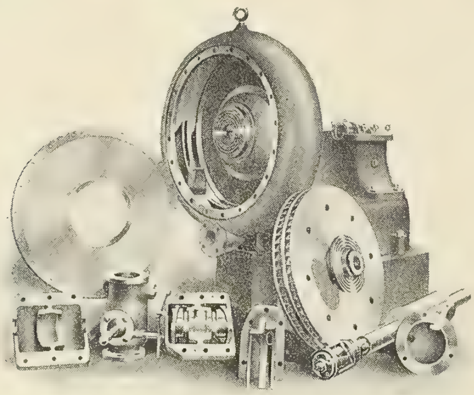
The E. W. Bliss Company, Brooklyn, N. Y., have just placed on the market a new steam turbine, which has been designed to meet the weaknesses of the various other turbines on the market and to take advantage of their strong features. In particular, structural strength has been sought, and the manufacturers claim to have developed a machine in which there is practically no danger of destroying vanes or guide blades.

The casing is of cast iron, having the steam chest carried concentrically around its outside and delivering the steam radially inward to each of the nozzles. This construction maintains an even temperature all around the circumference



and also does away with the necessity of having to bring any of the steam outside of the casing and then back into it again, as is necessary in some types of turbines.

The rotor or turbine wheel is made of one solid piece of open-hearth steel, which has the bucket seats milled into the periphery, making a very substantial construction. The buckets are separated from each other by sheets of a special anti-corrosive metal, which are held in place by three steel



bands shrunk on over the periphery. This method of construction makes a solid, unbroken surface on the periphery of the wheel, with no projecting parts, yet the wheel is as indestructible as if no separating pieces were used, while at the same time a new wheel would not be required in case of any trivial accident, like the damaging of a single bucket in transportation or handling. The running clearance is 1/16 inch, so that the machine cannot be considered delicate in this particular, and even if the turbine wheel should touch the casing, it would be a case of two smooth surfaces rubbing together, causing no damage.

The steam is expanded completely in the nozzles, so that there is no difference in pressure between the buckets in the wheel and the reversing chamber, and consequently no loss from leakage. The reversing chamber is common for all reversals, so that the steam runs on a film of steam instead of on metal, which greatly reduces the frictional losses, as the relative difference in velocity of each layer of steam with respect to the next is very small; whereas with separate reversing chambers the steam velocity relative to the metal is exceedingly high, and therefore causes large frictional losses, as the friction is very nearly proportional to the square of the relative velocities. The number of times which the steam is used on the wheel depends upon the steam pressure and the speed of the buckets, and in this nozzle the steam continues to strike the wheel as long as there is any energy in it, and not a fixed, definite number of times, irrespective of steam pressure and speed, as is the case in other turbines.

The packing around the shaft is a steel labyrinth packing, in which there is no contact between the stationary and rotating rings of the labyrinth. The packing prevents frictional losses, and does away with the trouble attendant with carbon packings or stuffing-box packings around a high-speed shaft.

The governor is of the centrifugal type, controlling a balanced governor valve through knife-edge connections. In addition to the main governor there is an independent emergency governor, set at a predetermined speed above normal, and operating a separate valve. Under the same conditions of steam pressure, back pressure and speed, the primary losses in efficiency in any turbine are caused by steam friction and leakage. In the "Bliss" turbine, as the steam is expanded down to the back pressure in the nozzle, there is no difference in pressure between any part of the wheel and the reversing chambers, which makes it possible to run with a very large clearance and still have no loss.

TECHNICAL PUBLICATIONS.

Reed's Engineer's Hand-Book. By W. H. Thorn & Son. Size, 5½ by 8½ inches. Pages, 798. Illustrations, 409. Plates, 37. Sunderland, 1909: Thomas Reed & Company, Ltd. Price, 14/– net.

This is the nineteenth edition of a hand-book which has long been considered by engineers all over the world as an authority on practical marine engineering. The book was written primarily to supply the necessary information to enable an engineer to pass the British Board of Trade examinations for first and second class engineers. Besides the part of the book dealing directly with questions asked in the Board of Trade examinations, 310 elementary questions are asked and brief answers given. Needless to say, the book is complete and extremely practical.

It is divided into five parts, exclusive of the elementary questions and answers. Part I., Arithmetic; Part II., Mensuration; Part III., Arithmetic of Marine Engineering; Part IV., Miscellaneous; Part V., Verbal Examination Questions, etc. Parts I. and II. have not been materially changed in the present edition, but Part III. has been entirely rewritten, the examples agreeing exactly with the questions in the Arithmetical Papers. The questions are worked up in such a way that by their solution a student arrives not only at the correct result but also learns the principles and methods involved. Part IV. is an entirely new feature, in which various subjects, such as turbines, oil motors, electricity, scale formation, indicator diagrams, slide valves, safety valves, boiler rules and the like are taken up. This is practically a detailed exposition of the subjects brought up in Part V., which is illustrative of the verbal and written part of the Board of Trade examinations.

By no means the least valuable part of the book is the collection of plates, including all the drawings required by candidates for first class certificates. These drawings are in large sizes, carefully worked up and well dimensioned. A small pamphlet, giving a complete explanation of these drawings, accompanies the plates.

The Great Lakes and the Vessels that Plough Them. By James Oliver Curwood. Size, 6½ by 9½ inches. Pages, 221. Illustrations, 72. New York and London, 1909: G. P. Putnam's Sons. Price, $3.50 net.

Few people until actually confronted by statistics and facts realize the immensity of the commerce carried on by the large fleets of steamers on the Great Lakes of North America, nor is it frequently realized how vast the shipping industry on the Lakes really is compared with the shipping industry on the coast. Facts and figures are brought out in this book to show the immense growth and importance of Lake shipping and Lake commerce. The book is not a mere collection of statistics, however, but an absorbing tale of human interest centered about great industries and great enterprises. Romance and tragedy have played their parts in the thrilling lives of the men who have built up the country about the Great Lakes, and probably nowhere in the world's history can a people more romantic and picturesque be found. Their history is a record of human achievement which it will well repay any one to study.

The Marine Steam Turbine. By J. W. Sothern. Size, 6 by 9 inches. Pages, 337. Numerous illustrations. London, 1909: Crosby, Lockwood & Son. Price, $5.00 and 12/6 net.

The first two editions of this book quickly gained a well-deserved popularity solely through their merit. The present volume, which is the third edition, although following the previous editions within a very short time, includes much new material, simply from the fact that recent rapid strides in the use of marine steam turbines have produced a considerable amount of data covering the performance and operation of various types of turbines. The descriptions of the various types of turbines and of the methods employed in workshops in building the turbines are the most practical and useful which we have seen. The great number of photographs and drawings which accompany the chapter containing data from actual practice are very valuable, and this part of the book undoubtedly forms the most comprehensive and reliable mass of marine turbine data yet published. What seems to be lacking in this, as well as in almost every other book on the marine steam turbine, is comprehensive information regarding the practical operation of turbines, such information as would be of use to the marine engineer, upon whom falls the duty of operating such plants.

Tables and Diagrams of the Thermal Properties of Saturated and Superheated Steam. By Lionel S. Marks, M. M. E., and Harvey N. Davis, Ph. D. Size, 6½ by 9 inches. Pages, 106. Figures 8. New York, 1909: Longmans, Green & Company. Price, $1.00 net.

Recent investigations by Dieterici, Griffiths, Henning and Joly give a trustworthy set of new values for the total heat of dry steam at pressures below atmospheric pressure, while the method recently elaborated by Dr. Davis, when applied to the throttling experiments of Grindley, Peake and Griessman, give remarkably accordant determinations at pressures above atmospheric pressure. The steam tables have, therefore, been recomputed, based upon these new properties, that are probably correct to one-tenth of 1 percent within the range of steam pressures usual in engineering practice. Supplementary tables extend the superheated steam table to very high temperatures and give the properties of water, metric conversion factors, Naperian logarithms and other quantities. Two large supplementary diagrams are also provided, which can be used instead of the tables if it is desired to facilitate certain computations.

The McGraw-Hill Book Department.

The announcement is made that the book departments of the Hill Publishing Company and McGraw Publishing Company have been consolidated under the name of the McGraw-Hill Book Department, at 239 West Thirty-ninth street, New York. The new company has taken over all the books issued by both companies, embracing 250 titles, including works on electricity, mining, metallurgy, machinery and civil and mechanical engineering. The officers of the new company are: John A. Hill, president; James H. McGraw, vice-president; Edward Caldwell, treasurer, and Martin M. Foss, secretary.

Obituary.

A. Bradshaw Holmes, secretary and treasurer of the Independent Pneumatic Tool Company and Aurora Automatic Machinery Company, Chicago, Ill., died on June 30, 1909, from injuries sustained by an accidental fall. He was 31 years of age, and had long been identified with the pneumatic tool business, having been connected with the Standard Pneumatic Tool Company and the Rand Drill Company for a number of years prior to his connection with the Independent Pneumatic Tool Company.

COMMUNICATION.

Regarding Producer-Gas Boats.

Editor International Marine Engineering:

Permit me to correct a statement made in the June issue of International Marine Engineering. On page 208 I read:

"Two years ago less than 300 horsepower was being developed by marine producer-gas plants; these were experimental in nature and were of the German Capitaine type."

Now, I personally know of fifteen marine producer-gas installations, delivered between 1902 and 1907, which were neither experimental nor influenced in any way by Capitaine.

A partial list of these installations follows:

Ship.	Dimensions. Feet.	Tons.	BHP	Knots.	Date.
Auguste Elise..	80 x 17. x 4.	90	21.5	4.3	1902
von der Feltz...	80 x 15. 3 x 4.7	120	21.5	4. 6	1903
Appingadam...	80 x 15.3 x 5.3	117	21.5	4.55	1903
Ziegelwerk I...	61 x 13.9 x 3.10	45	16	4.9	1904
Ziegelwerk II...	61 x 13.9 x 3.10	45	16	4.95	1904
Onderneming..	84 x 15.3 x 5.3	117	31	4.7	1904
Welvaren......	43 x 8. 6 x 3.10	20	7.5	4.9	1905
de Hoop.......	55 x 10.5 x 3.7	30	17.5	5.	1905
de Tijd.......	43 x 8.6 x 3.10	20	7.5	5.	1906
Georg Peter....	81 x 15.11 x 4.7	100	34.	4.9	1906
Adele Johanne.	81 x 15.11 x 4.7	100	34.	5.	1906
Volharding.....	61 x 12.2 x 5.3	60	17.5	4.85	1906
de Tijd........	87 x 15.3 x 6.5	174	34.	4.6	1906
Oldebert.......	61 x 11.7 x 5.6	50	17½	4.8	1906
de Hoop.......	....	50	27.	5.1	1907

The speeds are given in knots for a fully-loaded vessel. All these ships are freight boats on canals, rivers and lakes in Holland and Germany, many of them in regular service between two towns. Some of them are used for tugboats as well as freight boats, as their speed in fully-loaded condition would be greater than the 2.25 knots, which is the maximum speed allowed on some of the crowded canals.

All motors up to 35-brake-horsepower are vertical one-cylinder motors, the reversing being accomplished from deck by turning the propeller blades.

The builders of these boats (Messrs. E. T. Smit & Son, Groningen, Netherlands) have since delivered two 300-ton boats, with a vertical, three-cylinder, 120-brake-horsepower motor in each. F. Muller Brabel.

Hoogezand, Netherlands.

Reports from the Bureau of Navigation show that during the year ended June 30, 1909, 1,362 merchant vessels of 232,816 gross tons were built in the United States and officially numbered by the Bureau of Navigation, compared with 1,506 of 588,627 gross tons during the fiscal year 1908.

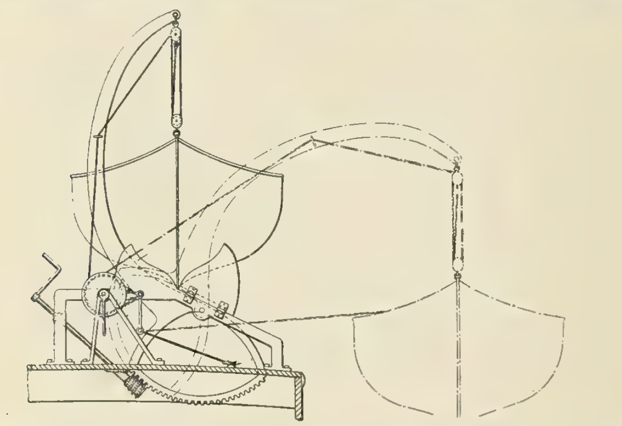
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

915,464. SHIP'S DAVIT. EVERETT W. MYERS, OF PORT TAMPA, FLA.

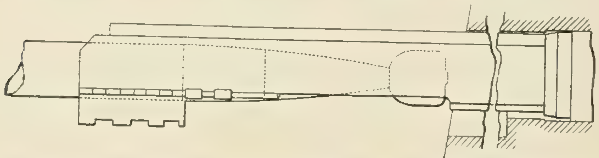
Claim 2.—A ship's davit for raising or lowering boats, comprising standards attached to the deck of the ship and carrying sectional chocks, one of the sections of each chock being fixed and the other section being hinged on a beveled incline for the hinged section to swing open when the boat is raised, cranes mounted to swing on the said standards



and having quadrant gears, worm wheels in mesh with the said quadrant gears, and having their manually controlled shafts journaled on the said standards and the ship's deck, and means for supporting the boat from the cranes and for raising and lowering the boat when the cranes are swung outward over the side of the vessel. Five claims.

916,164. APPARATUS FOR LAUNCHING TORPEDOES UNDER WATER. ALBERT EDWARD JONES, OF FIUME, AUSTRIA-HUNGARY, ASSIGNOR TO WHITEHEAD & CO., OF FIUME, AUSTRIA-HUNGARY.

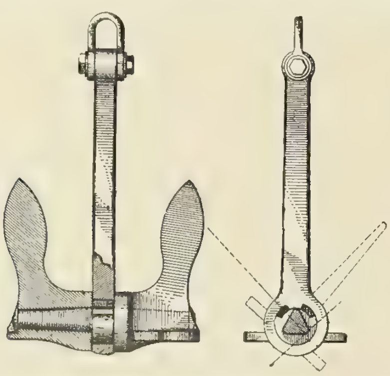
Claim. 5.—In combination with a torpedo launching apparatus, a supporting device, comprising openwork shutters provided only at the free extremity of the device, means for clutching said shutters with fixed members of the framework, rods engaging the shutters by means



of elongated screwthreads, said rods being incapable of rotation but capable of a movement of translation, means for automatically reversing the movement of said rods, and means for locking and unlocking the shutters. Five claims.

916,384. ANCHOR. FREDERICK BALDT, JR., OF CHESTER, PA.

Claim 1.—In an anchor, a spindle having a curved bearing portion, flukes mounted upon the spindle and interlocked therewith, and a shank



completely surrounding and directly rotatable on the bearing portion of the spindle, abutting the flukes and completely inclosing the bearing and filling the space between the flukes. Twelve claims.

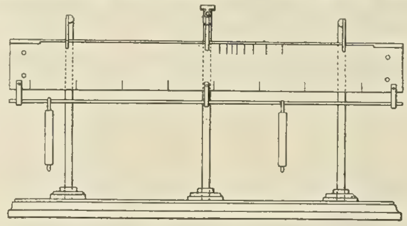
916,281. LOADING AND UNLOADING APPARATUS. MICHAEL G. DUCROW, OF NATCHEZ, MISS., ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO DUCROW LOADING AND UNLOADING MACHINE COMPANY, OF NATCHEZ, A CORPORATION OF MISSISSIPPI.

Claim.—An apparatus comprising a carriage having alining key-hole slots, a removable pin engaged in said slots, a carrier suspended from said pin, a trolley wire for said carriage, and means for moving the latter in opposite directions. One claim.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 4 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

14,704. APPARATUS FOR DETERMINING THE METACENTRIC HEIGHT. E. TATE AND J. M. GOODALL, LONDON.

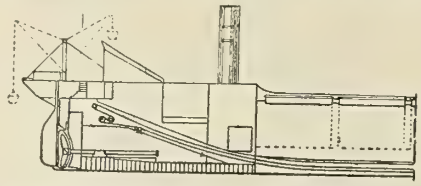
Claim.—A bar proportional in length to the depth and representing the light weight of the ship is marked to scale with the positions of the tank, top and decks, and also the positions of the transverse metacenter at every foot draft, from the light condition to the loadline. At the bottom is a rod upon which weights proportional to the weights of the cargo portions may be hung in the positions the actual cargo portions occupy as represented on the upper bar. This bar is normally carried



by davits, but in use, a central davit is caused to take its weight, being provided with a lever to which is pivoted a balance link whose legs straddle the upper web of the upper bar, so that when the tail of the lever is pressed downward its feet raise the upper bar by its web. The upper bar having been shifted along until it remains horizontal when raised, the position of the bar at the link denotes the center of gravity of the ship. The metacentric height is the distance between this position and the position of the transverse metacenter for the draft concerned, provided it is nearer the keel than the transverse metacenter mark.

24,261. UNLOADING SHIPS. C. D. DOXFORD, SUNDERLAND.

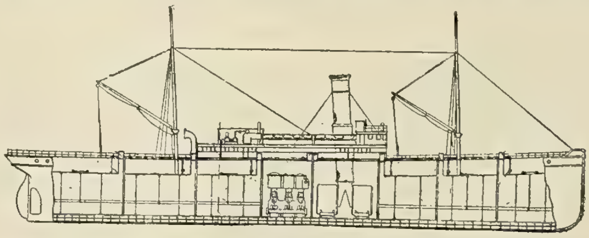
In steam or other motor-driven vessels, and having conveyers or runways extending beneath the holds, these conveyers are extended upwards aslant through the machinery space and bunker or fuel or boiler



spaces to an elevated discharge point. The vessels are preferably of the turret-deck form, in which case the discharge point, where the conveyers deliver to adjustable cross conveyers or shoots, is arranged beneath the weather deck.

24,481. RAISING SUNKEN VESSELS. W. W. WOTHERSPOON AND R. O. KING, NEW YORK, U. S. A.

The holds or compartments of ships or floating docks are so constructed that they may be rendered substantially air tight at will, in order that compressed air may be introduced into them to expel any water that may leak in. Also each compartment is provided with a permanent airlock, so that workmen may enter to repair the leaks, while the air pressure is maintained. The object of the invention is to guard against the sinking of vessels, and also to provide for the raising of stranded or sunken vessels. The holds or compartments, engine room and boiler room are separated from each other by partitions. The hatches are made air tight by the provision of packing, and the funnels are provided with lids or caps in order to render the boiler rooms air tight. Should a leak occur, compressed air passes from the air-compressing plant, which is situated preferably on a level with the upper deck,



through a vertical pipe to an horizontal main distributing pipe, from which vertical branch pipes lead to the various compartments. Each branch pipe is provided with a controlling valve, and also with a reducing valve, by means of which the pressure in the various compartments may be varied as conditions require. Each compartment is provided with an airlock, by means of which workmen may enter, while the pressure is maintained, to repair the leak. To withstand the pressure of the air, the tops of the compartments are strengthened, preferably by the bars connected with the top and bottom of the compartment, but other means may be employed. Instead of an airlock for each compartment, the airlock may be formed with a single entrance chamber and two branch chambers providing entrance into two adjacent compartments are provided between which an airlock is fitted. Workmen enter through the upper opening respectively. The funnels, ventilating shafts, and hatch covers are also provided with airlocks. In the funnel, two removable sections pass through the airlock and enter the boiler room through the lower opening.

International Marine Engineering

SEPTEMBER, 1909.

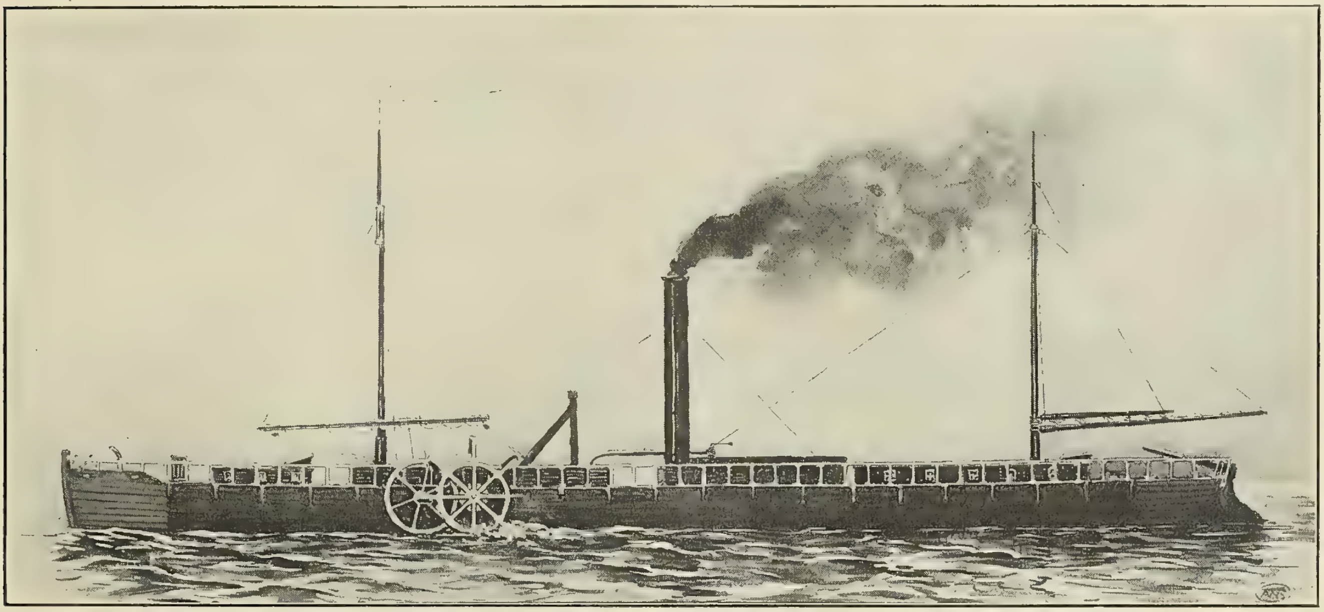
THE CLERMONT.

The first practical steamboat to engage successfully in commercial navigation was the *Clermont*, built by Robert Fulton in 1807, at Charles Brown's shipyard, near Corlear's Hook, New York, and placed in service on the Hudson River between New York and Albany. She was 150 feet long, 13 feet wide with 7 feet depth of hold and a draft of 2 feet. The hull was flat-bottomed and wall-sided, slightly wider at the deck than on the bottom, with a wedge-shaped bow and stern cut to an angle of 60 degrees. The parallel middle body extended for almost the entire length of the boat. Two masts and two cabins were fitted, one forward and one aft. She was steered by a tiller at the stern, and two lee-boards were fitted to prevent drifting sideways. Propulsion was by means of side paddle-wheels, placed well forward and driven by a single-cylinder, vertical, condensing, side lever type engine, supplied with steam at a pressure of 2 or 3 pounds per square inch by a copper boiler. The machinery was built in England, the engine by Boulton & Watt and the boiler by Cave & Son.

In connection with the Hudson-Fulton celebration to be held in New York this month a reproduction of this historic little vessel has been built as nearly like the original as would be allowed by the steamboat inspectors, and through the courtesy of the Hudson-Fulton Celebration Commission we are able to publish complete details of this replica. The principal dimensions of the boat, which differ from the original only in the matter of the beam, are as follows:

Length over all....................	150 feet.
Length at upper deck...............	149 feet.
Breadth at upper deck.............	17 feet 11 inches.
Breadth at bottom.................	16 feet.
Depth of hold......................	7 feet.

The stem is both sided and molded 8 inches, the stern post is sided 8 inches and molded 12 inches, and the deadwood is sided 8 inches and molded to suit. The floors are sided 4 inches, molded 8 inches and are spaced 24 inches center to center. They are single throughout the boat, with the exception of the machinery space, where they are double. The frames are sided 4 inches and molded 7 inches at the floors and 4 inches at the deck, and are spaced the same as the floors. The center keelson is 10 inches by 10 inches, and the engine, boiler and bilge keelsons 8 by 10 inches. The deck beams are molded 8 inches at the center, 5 inches at the ends, sided 8 inches and spaced 3 feet center to center. The main beams are fastened with hackmatack knees. The bottom planking is 2 by 4 inches, the three bilge strakes 10 by 2 inches, the sheer strakes 10 by 3 inches, the sheer stringer is 12 by 2 inches, and the wearing piece 8 by 3 inches. The deck planking is 4 by 2 inches.

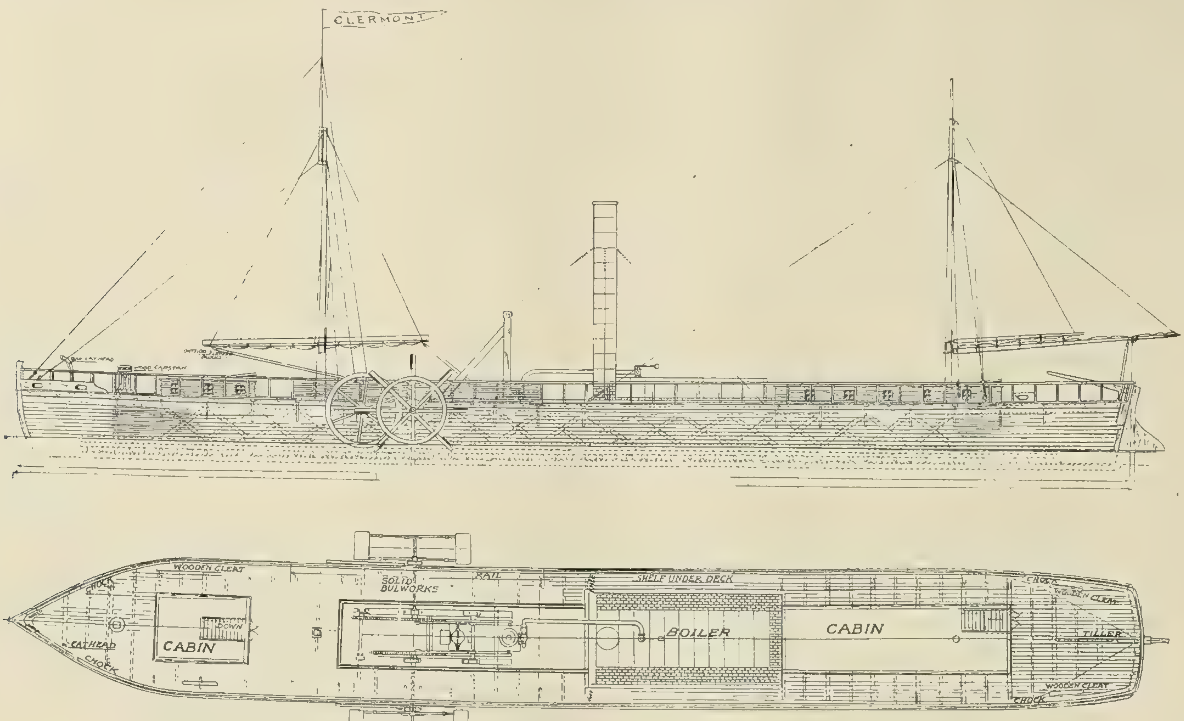


FULTON'S CLERMONT, THE FIRST PRACTICAL STEAMBOAT TO ENGAGE SUCCESSFULLY IN COMMERCIAL NAVIGATION.

The machinery of the *Clermont* is located amidships, and is entirely uncovered. The paddle-wheels are placed well forward; aft of these is the engine and aft of this again the boiler. The paddle-wheels are 15 feet in diameter, each having eight paddles or buckets 4 feet long and 2 feet wide. Forward of the paddle shaft and connected to it through two to one gears is a jack-shaft, on which are mounted two large fly-wheels, arranged outside the hull. These fly-wheels have cast iron rims, 4 inches by 4 inches, and are keyed to the shaft.

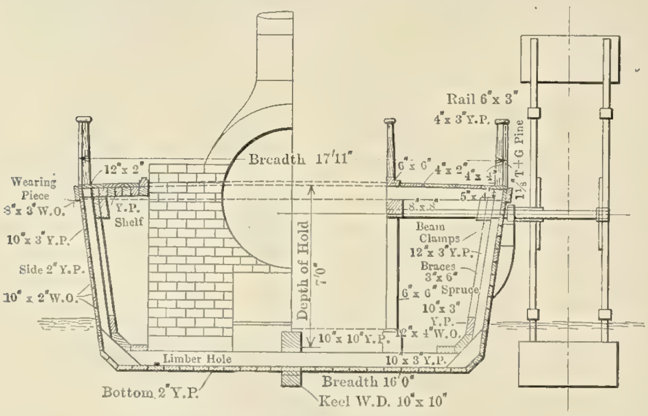
The engine is of the single-cylinder, condensing, side-lever type, designed for a working pressure of 20 pounds per square inch. The cylinder is mounted on a cylindrical condenser, which is connected to the air pump by a channel-way of cast iron, which forms the bedplate of the engine. One boiler-feed

pump is supplied, which has a capacity of 180 cubic inches, and is worked by the air pump cross-head. It has a brass plunger and valve. The bilge pump has a capacity of about 300 cubic inches. The side levers of the main engine are of cast iron on a wrought iron center shaft. Each connecting rod is forked and fitted with wrought pins. Counter weights are provided to balance the weight of the piston, piston rod, crank, side links, air pump gear, etc.



GENERAL ARRANGEMENT OF THE CLERMONT.

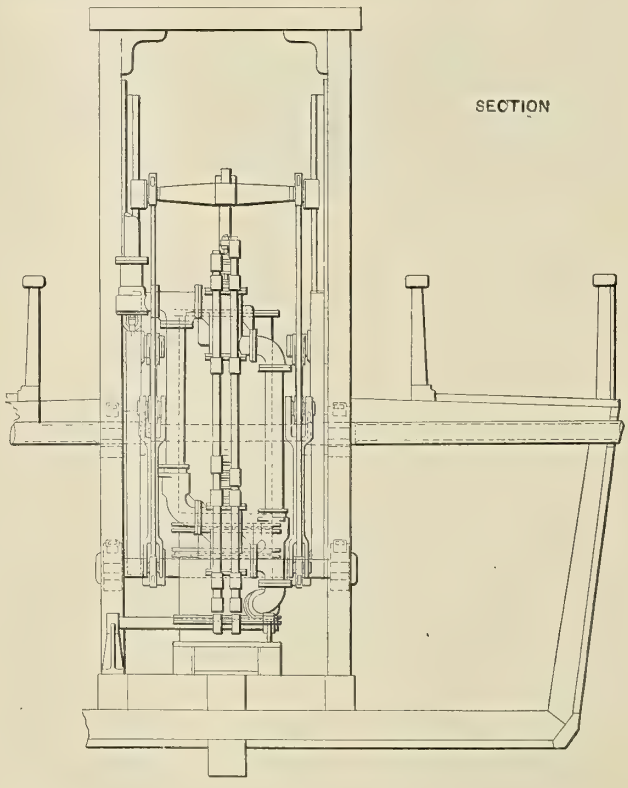
No attempt was made to reproduce the original boiler of the *Clermont* exactly, because such a boiler would not be allowed in operation to-day by the steamboat inspection service. The boiler used on the replica is an ordinary externally-fired horizontal tubular boiler, 5 feet 6 inches diameter, 16 feet long, with ¼-inch shell, 5/16-inch heads and forty-six 4-inch tubes, designed for a working pressure of 25 pounds per square inch.



MIDSHIP SECTION OF THE CLERMONT.

As showing the extent of the theoretical knowledge of naval architecture and marine engineering in Fulton's time the following extract from one of Fulton's letters is of interest:

"My first steamboat on the Hudson's River was 150 ft. long, 13 ft. wide, drawing 2 ft. of water, bow and stern 60 degrees; she displaced 36.40 cubic ft. equal 100 tons of water; her bow presented 26 ft. to the water, plus and minus the resistance of 1 ft.; running 4 miles an hour.

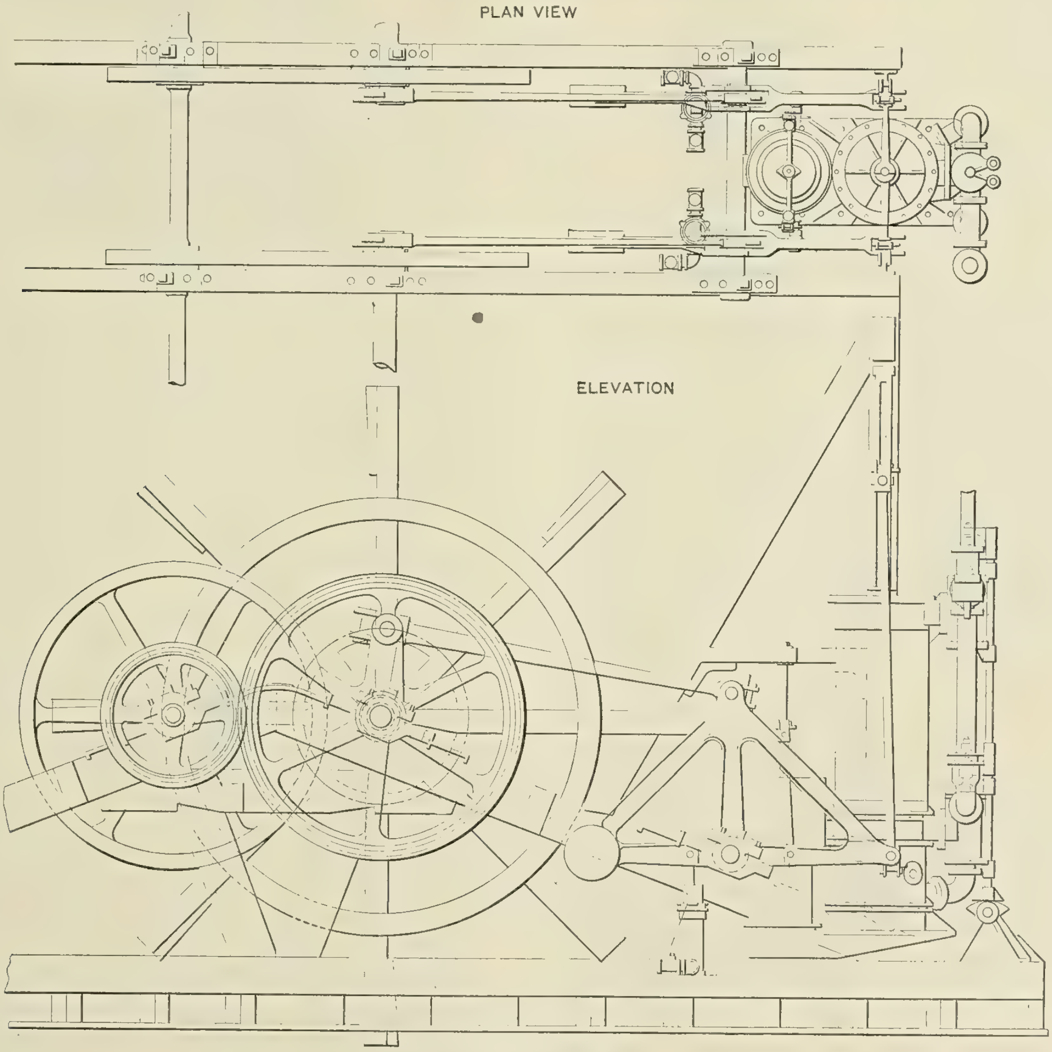


END VIEW OF THE MAIN ENGINE.

THE MAURETANIA AND THE CLERMONT, SHOWING A CENTURY'S PROGRESS IN STEAM NAVIGATION.

12.37 lbs. multiplied by 26, the bow of the boat.....	321 lbs.
Friction on 2,380 superficial ft. of bottom and sides, 7.50 lbs. or 50 superficial ft......................	352
Total resistance of the boat, running 4 miles an hour	673
A like power for the propellers....................	673
Total power felt at the propellers..............	1346
The boat running 4 miles an hour is 6 ft. a second; this is three times faster than the piston; hence multiplied by.................................	3
Necessary power of the engine, the piston running 2 ft. a second.................................	4038 lbs."

The first voyage of the *Clermont* was begun on Aug. 17, 1807, the boat proceeding from New York up the Hudson River for 110 miles during the first twenty-four hours. The average speed thus far had been about 4.6 miles per hour. Continuing the journey on the following day the *Clermont* proceeded to Albany, a distance of 40 miles, in eight hours. The running time for the entire trip of 150 miles from New York to Albany had been thirty-two hours, or at the rate of nearly 5 miles an hour. The return trip was made in thirty hours' running time, or an average of just 5 miles an hour. This same trip is made to-day in the regular running time of nine and one-half hours by boats capable of an average speed of 20 miles an hour.



MAIN ENGINE OF THE CLERMONT.

THE DEVELOPMENT OF THE SAILING SHIP.

BY SYDNEY F. WALKER.

Forty years ago, when the writer was serving in H. M. Navy, the sea was covered with sailing ships of all classes, ranging from the fore-and-aft schooner to the stately full-rigged ship. When crossing the trade winds, or when running them down, one constantly met a stream of ships and barks ranging from 500 up to about 2,000 tons, with every stitch of sail upon them. The navies of the world also were propelled by sails. It is true their ships carried steam, but it was only as an auxiliary, and the horsepower was very small. Frigates of 2,000 tons, with only 500 horsepower, were the largest naval sailing ships afloat. To-day, however, the sailing ship is steadily disappearing, although a few four and five-masters may stil be seen, and small fore-and-aft rigged sailing vessels are quite numerous on the Atlantic and Pacific coasts of the Americas and in the neighborhood of Australia, China and the Islands. The fore-and-aft rigged craft will probably be the last to succumb, and in the writer's opinion the conqueror will not be steam, as was the case with the square-rigged vessels, but oil or producer-gas power.

GALLEYS.

The history of ships goes back as far as history itself. The Greeks, Romans and Carthaginians not only had fleets, but important battles were often fought at sea between the fleets. The parents of the Carthaginians, the Phœnicians, also were great sea rovers. Ships of various kinds were used upon the Nile from the very dawn of history, and they appear also to have been used by the Assyrian and Babylonian kings on the Tigris and Euphrates, and upon the canals that were dug all over Mesopotamia.

Although it is not possible to obtain very accurate accounts of the ships of those early days, we know that they were almost entirely propelled by oars, and, further, that slaves were employed in them. The galleys, in the case of the Greeks at any rate, appear to have been developed on very much the same lines as the old three-deck men-of-war of the 18th and 19th centuries. In order to obtain greater speed, and to enable a galley to carry a larger number of fighting men, a larger number of oars were necessary, and they appear to have been obtained by increasing the free board of the galley, and placing the tiers of benches, or thwarts, one above the other, presumably separated by decks, each tier carrying a bank of oars, each oar being manned by a certain number of slaves. The Greeks are stated to have employed as many as five banks of oars, vertically one above the other. Alexander the Great had galleys with four and five banks, and the Carthaginians used five banks and a sail. The Greek trireme, carrying three banks of oars, was apparently quite common. The galleys of those days employed sails only when the wind was favorable, and sails were not always carried.

Galleys appear to have persisted down to the Middle Ages. The Genoese and Venetians employed them, apparently some time after other nations had adopted sailing ships. The Genoese and Venetian galleys, in which a very large trade was carried on, and in which war was also pursued, were usually 150 feet long, about 20 feet wide at the widest part, and carried two masts, each with a lateen sail. They had a forecastle in the fore part of the ship, where the fighting men were accommodated, a poop or after castle at the stern, where the knights and officers were carried, and a short deck, just forward of the poop, probably the origin of the term quarter deck, that has come down to us. The galley was used in France down to the 18th century.

The galleot was a large galley, with poop and forecastle, employed by the Barbary corsairs, and the Spanish and Portuguese galleons and the Neapolitan galleasses grew from the old Venetian and Genoese galleys by the ordinary process of development. The addition of the poop and forecastle and quarter deck led to a complete deck above the waist, where the rowers sat, arranged to carry a second crew of rowers, and when artillery came into use these decks were employed to carry guns.

The Viking ships, which carried the Norsemen who conquered Great Britain, the northern coast of France, which is now called Normandy, and other parts, were galleys. One has recently been found in Norway, and is preserved at Christiania. It is clinker built, 78 feet long, 7 feet beam amidships, 5¾ feet deep. Its draft was less than 4 feet, and it carried thirty-two oars and a mast 40 feet high. The hardy Norseman, the writer understands, did not venture very far out of sight of land, and this was the characteristic of practically the whole of early navigation. Sailing also was not at all common in the early days of ships. The wind was not understood, and it was very much feared. It was used when it was available, strictly to run before.

It is not clear when sails became the important part of a ship's equipment that they were in the latter part of the 18th and nearly the whole of the 19th century. Probably it was a gradual development. In old prints the ships in which William

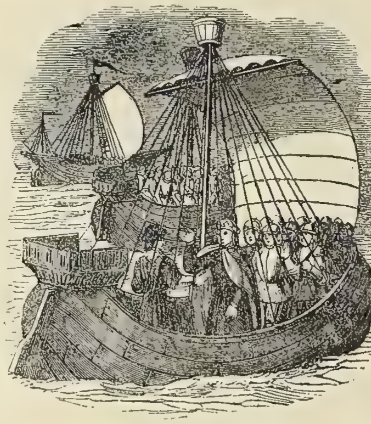


FIG. 1.—SHIPS OF THE 14TH AND 15TH CENTURIES.

the Conqueror crossed the channel are represented with lug sails. Evidently they were only arranged for running before the wind. The ships of the time of the 14th and 15th centuries, Fig. 1, are represented also with sails only intended to be used before the wind. The ships of William the Conqueror, and right down to the 15th century, are represented as practically large, open boats, with towers or structures at the bows and sterns, corresponding to poop and forecastle, with a mast amidships.

FIRST IMPORTANT PROGRESS IN SHIPBUILDING.

It was not until the time of Henry VII. and Henry VIII. that any really important progress appears to have been made in shipbuilding. In fact, though Alfred is usually understood to be the father of the British Navy, Henry VIII. might be more correctly so described. In his time the *Henri Grace-à-Dieu*, shown in Fig. 2, was built. It will be noticed that it carries four masts, the fore and after castles, the latter being called the poop and the waist, and that there is the heavy superstructure which characterized all ships of that day. Apparently she carried lower sails, courses as we should now term them, on all four masts and topsails. She also appears to have carried a sail corresponding to what afterwards was called the jib, and another corresponding roughly to the spanker. The round tops shown on each of the masts had been introduced into previous ships for the use of the pilot.

In Henry VIII's time ships were still in a very crude condi-

tion, but important developments were going forward. The *Henri Grace-à-Dieu* was of 1,000 tons burden, and is stated to have had two decks. Probably what is meant is that the large superstructure of the poop and forecastle practically formed a second deck. About this time, or a little later, top-gallant sails appear to have been introduced, and also some of the fore-and-aft sails, the jib, trysails and spanker, which afterwards became so useful. Developments went on during

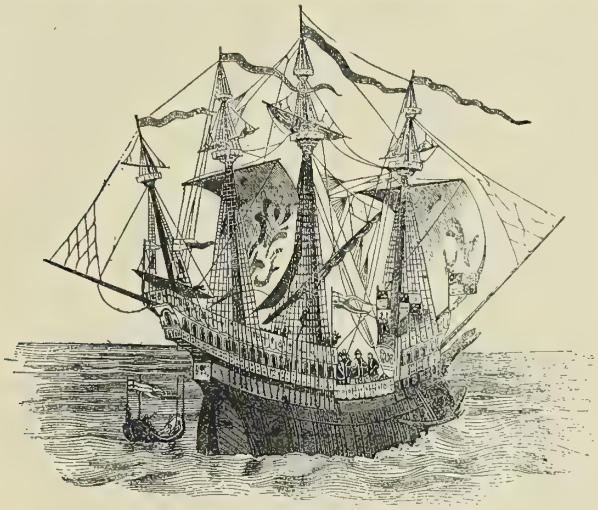


FIG. 2.—THE HENRI GRACE-À-DIEU.

the reign of Elizabeth, and, as is well known, the superior sailing qualities of British ships enabled them to harass the bulky Spanish ships.

The Spanish galleons were built in very much the same style as the *Henri Grace-à-Dieu,* with high poops and high forecastles and with quarter and half-decks, and in several cases with two gun decks in addition. The poop and forecastle were originally castles built at the stern and bows. The half-deck was a short deck extending forward from the poop towards the forecastle, and the quarter-deck was another short deck above the half-deck. The quarter-deck, which has become almost historic, would naturally be the point where the officers, who usually lived in the poop, met deputations from the men, and where the men who had to see officers would find them. The half-deck in men-of-war at the time the writer was in the navy was the after portion of the main deck, the principal gun deck, immediately under the quarter-deck.

TWO AND THREE-DECK VESSELS.

In James I.'s time many improvements were made in the design of ships by Sir Phineas Pett, who was practically the first scientific naval architect, the first man who thoroughly studied the problems involved in shipbuilding. One of the earliest reforms introduced by Pett was the doing away with a large portion of the heavy superstructures that have been mentioned, and that were carried by practically all ships up to that date. Other important improvements were made. Charles I. also, though he was so unfortunate in his government, did a great deal for the navy, following in his father's footsteps. It was in his reign that the first three-decker, the *Sovereign of the Seas,* shown in Fig. 3, was built. She carried a very long bowsprit, a very long prow, three distinct gun decks, besides a very high poop and a high forecastle. The half and quarter-decks also are easily made out. She carried four masts. Each mast had a round top just above the lower yard, and another top above the topsail yard. All but the after mast carried lower sails, or courses, topsails and top-gallant sails. The masts had been made all in one piece, lower mast and topmast, but in Sir Walter Raleigh's time the topmast appears to have been made a separate piece, stepped in the top, and arranged so that it could be sent down, and in later times the top-gallant mast, which included in still later times the royal pole, was also made separate. The small round tops shown at the head of the topmasts of the *Sovereign of the Seas* afterwards became the cross trees of the modern sailing ship. The bowsprit appears to have been first introduced in the reign of Edward III., but it was not until very much later that it was made use of in the manner in which it was afterwards employed, to spread fore and aft sails.

A point may be noted here with reference to the mercantile marine. In the early days of shipping there was practically no mercantile marine, in the sense we now understand it. Men went to sea for the purpose of trading in ships found by themselves or by adventurers, and in most cases the ships were heavily armed, amounting practically to warships. In later times, the development of ships intended solely for trading took on its own special lines. Trading ships had to be built for speed and for carrying as much cargo as possible. Sea passenger traffic in those days was very small. As time went on it also gradually developed, and ships were developed to meet its requirements, till they have reached the enormous liners of to-day. The advent of steam has, of course, fostered the passenger traffic, partly because steam enables passages to be made in so much shorter time, and steamers can be made more comfortable for passengers than sailing ships, though for the seaman, for the man who loves the sea, the reverse holds good.

The navies of the world were practically developed on much the same lines. The necessity for carrying more guns could only be met in those days by building ships with more decks, and so, although the *Sovereign of the Seas* was only imitated at a considerably later period, and was herself cut down considerably before the expiration of her useful life, the two and three-decker came into existence.

It was not, however, till the rivalry between Holland and Great Britain on the one hand, and between France, Spain and

FIG. 3.—THE SOVEREIGN OF THE SEAS. THE FIRST THREE-DECKER.

Great Britain on the other, was fully developed in the 18th century, that the building of ships of war settled down to certain definite lines. The length of the keel of the *Sovereign of the Seas* was 128 feet, her beam was 48 feet, her total length from the end of the beak to the end of the stern was 232 feet, and her burden was 1,637 tons. Other three-deckers were built at various dates, among them the *Victory,* in 1786, whose length was 186 feet, burden 2,100 tons, and which carried one hundred 32-pounder guns; the *Duke of Wellington,* in 1849, of 3,771 tons, 240 feet long, carrying 131 guns; the *Marlborough,* in 1850, of 4,000 tons, with a steam-driven screw as an auxiliary, and in 1860 the last of the old three-deckers, the *Victoria,* was built. The three-decker carried from 100 to 131 guns, according to her size.

In the period mentioned, from the middle of the 18th century up towards the end of the 19th century, in addition to three-deckers there were a fair number of two-deckers carrying 74 and 80 guns.

RIGS.

The two and three-deckers were fully rigged. They carried three masts, a bowsprit with jibboom and flying jibboom. Each mast carried a topmast, top-gallant mast and royal pole. On the fore and main masts were carried the following square sails: Courses secured to the fore and main yards, topsails spread between the topsail and lower yards, top-gallant sails spread between the top-gallant and topsail yards, and royals spread between the royal and top-gallant yards. The mizzen mast, as the after mast was called, carried the same sails, with the exception of the lower one. The lower yard on the mizzen mast was called the cross-jack yard, the yards above it being called mizzen topsail, top-gallant and royal yards, respectively. There was no cross-jack course. In addition to these sails there was a three-cornered jib, secured to a stay held between the head of the fore mast and the end of the jibboom; a flying jib, carried upon a stay, secured to the end of the flying jibboom, and for bad weather a fore-staysail, a three-cornered sail, secured to the fore-stay, which was stretched between the head of the fore mast and the bows of the ship. Abaft the mizzen mast was carried the spanker, a sail similar in form to the mainsail of a schooner, and stretched between a gaff, a boom and the mizzen mast. The spanker was of great service in keeping the ship to the wind when sailing close hauled, and particularly in tacking. Storm trysails were also carried on gaffs attached to the fore and main mast, similar in shape to a schooner's fore sail, and spread in a similar manner. They were only used in bad weather. In addition, all ships carried another set of sails for light weather when the wind was abeam or abaft the beam, called studding sails, pronounced "stunsails." They were oblong in shape, and formed continuations of the fore and main topsails and top-gallant sails. They were stretched between studding sail booms, run out at the ends of the lower and topsail yards and yards which stretch their heads.

FIG. 4.—MODERN TYPE OF SAILING VESSEL. THE WHITE STAR TRAINING SHIP.

FRIGATES, CORVETTES AND SLOOPS.

In addition to two and three-deckers a certain number of frigates were carried by all nations. The frigate of those days corresponded to the cruiser of to-day. It acted as a scout, but a large number of them were of sufficient power to defend themselves if attacked, and occasionaly to take their place in the fighting line on emergency. In later times, in the late sixties and seventies, frigates were the largest ships of the Old World patterns to keep the sea.

The frigate was built on exactly the same lines as the two and three-deckers. She had one gun deck, known as the main deck, and in addition she carried guns on the quarter deck, sometimes on the poop, if there was one, and on the forecastle. The frigates were ship rigged exactly the same as two and three-deckers, the only difference between them being that they did not stand so high above the water and did not carry so many guns.

In addition to the above there was a class of ships in the navy in those days known as corvettes. They were usually ship rigged, and would correspond to second-class cruisers of the present day. They only carried guns on the upper deck, quarter-deck, forecastle, etc. There was a still smaller class of cruiser, as it would now be termed, known as a sloop. It was sometimes ship rigged and sometimes bark rigged. Sloops also only carried guns on the upper deck, and were similar to corvettes, except that they were smaller. There was still another class of vessels carried in most navies, known as gun boats. They carried three masts, but usually only square sails on the fore mast. Practically they would be three-masted topsail schooners. They carried a few guns on the upper deck, the men and officers living on the deck below.

In the mercantile marine, which had fully developed by the time referred to above, ships were built on very much the same lines as those for the navy, except that there were no two or three-deckers, and there were no gun decks. Large ocean traders, equal in size to frigates and ship rigged, were built for carrying cargo and a certain number of passengers, the accommodation for the latter, as explained, steadily increasing as the traffic increased. In addition there were a very large number of smaller vessels, some ship rigged, some bark rigged, some rigged as brigs, some as brigantines, topsail schooners and fore-and-aft schooners. The tonnage of barks and ships ranged from about 500 to up to 2,000, brigs, brigantines and schooners ranging from a few hundred tons downwards. The brig carried two masts, with square sails on each and the same fore-and-aft sails as the ship. The brigantine carried two masts, with square sails only on the fore mast, but she carried a full complement of sails there, and in some cases top-sails, top-gallant sails and royals on the main mast. Topsail schooners carried two masts, and had square topsails on the fore mast in addition to their fore-and-aft sails. Fig. 4 shows the White Star Company's training ship for their cadets. It has the latest sailing ship fittings. In addition to the usual sails carried by ship-rigged vessels, as described above, merchant ships often carried additional sails above the royals, for getting more speed out of the ship, when it was safe, as when running down the trade winds. The sails immediately above the royals were known as sky sails. Sometimes sails were carried even above those, known as moon rakers, and so on.

CONSTRUCTION OF WOODEN SAILING SHIPS.

Wooden sailing ships were constructed on very much the same lines as iron ships are, with the necessary difference that the wooden framework, etc., had to be very much thicker and very much larger, the whole skin of the ship, and the different parts entering into its construction, taking up very much more room than in iron or steel-built ships. In the wooden ship there was first the keel, which was of teak, with a stem and stern post securely scarfed and bolted to it, and with the ribs, or timbers as they were usually called, stepping into it. On top of the keel, and holding the lower ends of the timbers in their place, was the keelson, another piece of stout oak. On the inside again, forward, was the stemson, and aft a similar timber, holding the outer timbers, running between stem and stern, in their place.

The ribs were the result of careful design, and were usually either cut out of solid timber or bent into their form by special appliances. Upon the careful design, careful construction and careful fixing of the ribs depended the capacity of the ship, its stability, its speed and its ability to stand bad weather. Great care was taken with the shape of the ribs forming the bows, and again those forming the run near the stern. The construction of the after part of the ship, allowing a clear passage for the water displaced by the bows as the ship cleaves her way, has as much to do with speed as the shape of her bows. Naturally, the shape of the bows also was the subject of considerable thought and skill, and old seamen used to say that for speed the shape of fishes like the dolphin should be taken as a guide.

The skin of the ship was completed by outside timbers, bolted to the ribs secured to the stem and stern post, being held in their places by the stemson and sternson. There was also usually an inner planking of wood connecting the ribs with the stem and stern post, and the keelson fore and aft. The beams, which stretched across the ship at intervals, performed the double office of supporting the different decks and of assisting to bear the strains to which the ship's timbers were subjected.

The construction of men-of-war differed from that of merchant ships, in that men-of-war were designed to carry guns and to provide accommodation for men, and therefore the interior of the ship was divided up by as many decks as possible, while with merchant ships the great object was to obtain as large a space as possible under the upper deck, in order to stow cargo. With the development of passenger traffic, merchant ships also became more and more divided up by decks, to provide accommodation for the passengers, and the construction more and more approached that of men-of-war. In men-of-war there were holds below the lowest decks in which the stores required by the ship—provisions, ammunition and spare sails, boatswain stores of all kinds—were kept.

TRANSITION FROM WOOD TO STEEL-BUILT SHIPS.

The first steps in displacing wood by iron and later by steel were taken by navies in building what were known as ironclads in the sixties. H. M. S. *Caledonia* and others were really wooden ships with a protection of iron outside of the wood, the object being to offer a greater resistance to the rifled shot and shell which was then gradually being developed. In those days steel was thought to be unsuitable for the work, because the steel plates which had been made and applied to the protection of ships had been found to break up when pounded by rifled shot.

At the same period the transition from sail to steam was in progress. Nearly every man-of-war of those days was fitted with a screw and with a certain amount of engine power, but it was strictly auxiliary. The screw was made to be pulled up out of the water, in a well made specially for the purpose, and steaming was resorted to as seldom as possible.

Several experimental ships were built by the British and other navies about the same time, and a number of new classes of ships were introduced in America during the civil war, these leading indirectly to the present form of modern battleship.

In the mercantile marine the development appears to have followed very much the same lines as in the navy. Steam was first applied, hardly as an auxiliary, in the same sense as in the navy, but sails were not dispensed with, nor even curtailed, for a very long period. In the *Great Britain,* which was built in 1852, and which had four masts, steam was intended to be the motive power, but it was to be assisted as far as was possible by the sails. Steam was applied in this way by the great steamship lines trading between Great Britain and the United States, and between Great Britain and Canada, and between Great Britain and Australia. As time went on, and as the ships became larger, and, again, as more speed was demanded, the engine power was increased, and the sails became gradually of less and less importance, till they finally disappeared.

The transition from wood construction to first iron and then steel has been gradual but continuous, and it has been contemporary, or nearly so, with the development of steam. It may be taken, in fact, that the development of the manufacture of steel, the development of steam power for ships, and the adaptation of steel for building ships have gone on together, and they all date practically from the invention of Bessemer steel.

The modern four and five-master is built of steel, and differs very little in construction from that of the modern steam tramp, except that as there are no engines and boilers more room is provided for cargo, and there is no necessity for providing in the structure of the vessel for the strains set up by the vibration of the engines. On the other hand, provision has to be made for the masts, sails, etc., and for the rigging, and also the ship as a whole, should be built more strongly than would be necessary with a steamship, because the sailing ship cannot lie head to wind and head to sea in bad weather.

THE HALF MOON.

Three hundred years ago Henry Hudson sailed into New York harbor and began the exploration of the river which has since borne his name. This was Hudson's third voyage of discovery, the main object of all his voyages being to discover a northwest passage to the Pacific Ocean and China. On his two previous voyages, which were carried out under English auspices, he endeavored to reach China by passing, in one case, between Greenland and Spitzbergen and across the polar region, and in the other case between Spitzbergen and Nova Zembla. Both of these voyages were failures as far as their original object was concerned, but their secondary results were important, for Hudson's discoveries of Arctic whale fisheries led to the establishment of very valuable sea industries both among the Dutch and the English.

The third voyage, which resulted from a contract with the Dutch East India Company, led to the exploration of the Hudson River and the settlement of New Netherland. This voyage, like the previous ones, was an attempt to discover a northwest passage to the Pacific.

The vessel in which Hudson made this memorable voyage was the *Half Moon,* or, as it was spelled in Dutch, *De Halve Maene.* The *Half Moon* was a small vessel even for her own times, and as compared with the monster ships which to-day enter New York harbor she is hardly more than a midget. Few people would care to venture to sea to-day in such a craft, and that Hudson was able to complete successfully such a long and hazardous voyage in such a boat speaks well for his skill as a navigator.

The *Half Moon* was only 74.54 feet long over all, and 58.70 feet long on the waterline. Her beam was 16.94 feet, her depth 10.08 feet (English measure), and her draft 7.03 feet. A replica of this famous ship has been built by the people of Holland to take part in the forthcoming Hudson-Fulton celebration at New York, and through the courtesy of the Hudson-Fulton Celebration Commission we are able to present photographs and the following detailed description of this ship as an example of the development of naval architecture 300 years ago.

The ship has three masts; on the foremast are fixed the fore-topsail and foresail (the "blind sail" is on the bowsprit); on the mainmast is the maintopsail and mainsail, while on the mizzen mast a lateen sail is fastened.

BOW VIEW OF THE HALF MOON.

The captain's cabin under the poop has been built on the upper deck. In the cabin, under the berth, is a chest, beautifully bound, containing books. On the table lies a sea chart and a copy of the contract with Hudson for this voyage, copied from the minute book of the directors of the East India Company of the Chamber of Amsterdam, dated Jan. 8, 1609. Around this are the dividers and little pieces of wood for measuring Further, there is in the cabin a Jacob's staff, really a very primitive sextant, by means of which the navigators 300 years ago determined the latitude with a fair degree of accuracy. Above the captain's cabin is the one for the mate, still smaller and simpler. The best observation point in the ship is

the poop, from which the whole ship can be seen. Forward is the forecastle, the sleeping place of the crew, with five berths, in each of which if necessary two men can sleep; under the bowsprit is the galley, where the sailors, for punishment, were exposed to the seawater, and where was fastened the "blind sail," so called because it interrupted the pilot's view. On the deck are two blocks, to which the ropes are fastened. One of them has the ordinary head of a seaman, with his mouth open as if yawning; further back is the steersman's platform, over which a little roof has been built for the steersman; the rudder being moved by the whipstaff which is bound to the tiller. The steersman has before him a compass, a sand-glass and a log-glass.

Under the upper deck is the 'tweendeck or "verdeck." In this are the hawse holes for the anchor. Further, there is the very primitive kitchen and the berth for the cook, a sail room, and at the stern the gunner's room, where the powder is stored, the bread room and the berth for the steward. Underneath is the hold for the provisions, the drinking water, the cables and, lastly, for the cargo.

The armament consists of two small and two large cannon. On the deck near the railing stand the small ones, that is, swivel guns, also called "kamerstukjes"; these are 100-pound pieces. In the 'tweendeck space are two heavy pieces of 800 pounds each.

Part of the equipment is a small ship's boat similar to a cutter, which is fastened to the deck above the main hatch aft of the foremast.

The *Half Moon* has at its rail the East India Company's flag, the national tri-color, with the well-known monogram, V. O. C.—Veroenigd Oost-Indische Compagnieen (the United East India Companies)—in the white stripe above which is the letter "A," an indication that it was the Amsterdam Chamber which commissioned Hudson. On the bowsprit is a small jack of orange, white and blue. The flag of Amsterdam flies from the foremast; the state flag of the Province of Holland (gold with red lion) is on the mainmast, and a small vane on the mizzenmast.

There are two hatches, one forward and one aft. The forward hatch is scarcely large enough for a man to pass through, and the after one is little better. The hold extends the entire length of the vessel, and a wood pump tube runs down from the upper deck to the bottom of the hold, to serve the purpose of a bilge pump. This pump tube is about a foot in diameter, and is hollowed or bored out from a tree trunk. It is operated from the upper deck by means of a wooden handle.

STERN VIEW OF THE HALF MOON.

It is remarkable how the crew were able to handle the vessel when the quarters on board were so cramped. Forward of the companionway the space between decks was only about 4 feet, and aft it was only a foot higher, scarcely permitting one to stand upright.

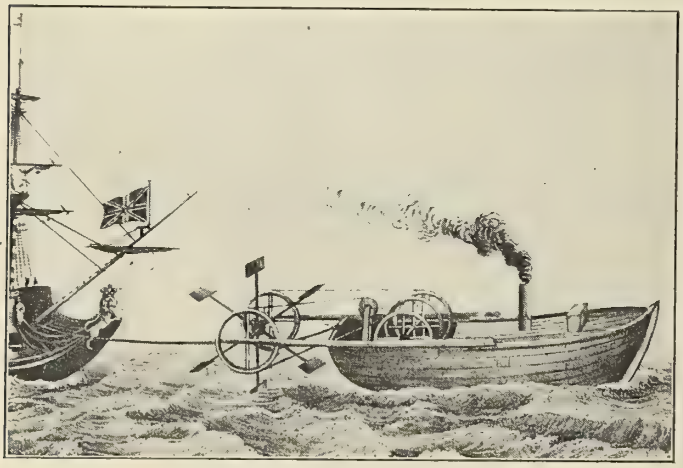
After spending about a month exploring the river up as far as he found it navigable, Hudson returned to England, and a year later, again under English auspices, set forth on his fourth and last quest of the northwest passage. This resulted in the exploration of Hudson's Bay, but Hudson himself was abandoned by a mutinous crew.

PIONEER PADDLE-BOATS IN BRITAIN.

BY G. PINHORNE, M. I. N. A.

To "make a Boate to goe without Oares or Sayles * * * * against Wind and Tyde" is an oft-recurring claim in the earliest-recorded speculations or experiments of philosophers and mechanics. It perhaps would be invidious, and certainly controversial, to urge originality, or even comparative importance, to any one of these. Each and all, the known world over, contributed a quota to the perfecting of our knowledge of mechanical appliances or the properties of steam, and thus helped to make steam navigation an accomplished fact at the commencement of the nineteenth century.

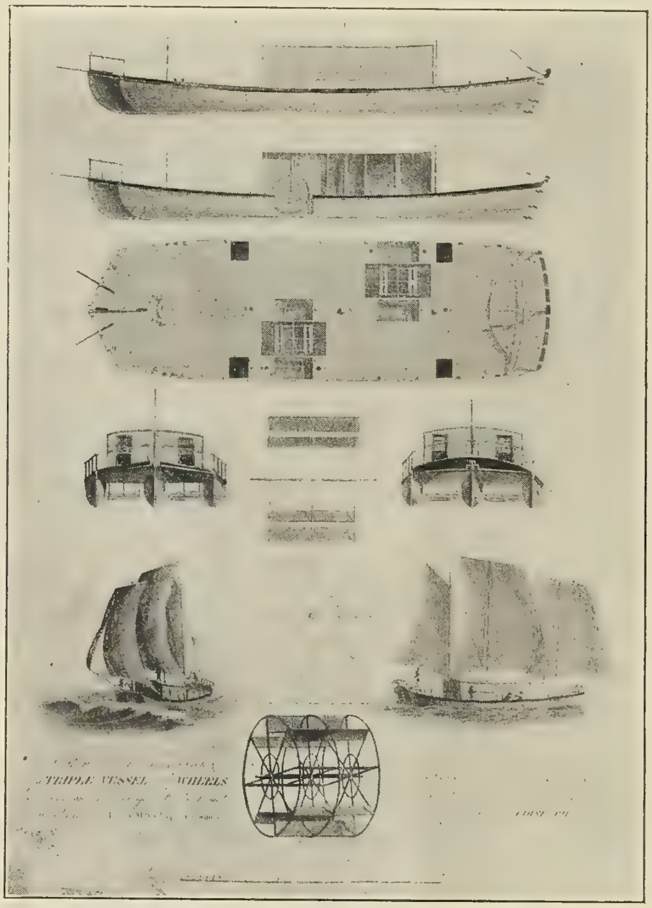
Foremost among the early patentees of ideas relating to steam-propelled vessels may be fairly mentioned Jonathan Hulls, the Gloucestershire yeoman—our selective preference being largely influenced by his detailed descriptions and drawings, as well as by the immense suggestiveness of his ideas in the light of subsequent progress. The illustrated pamphlet, published in 1737, describing his invention, depicts a barge-like vessel carrying a large paddle-wheel, supported upon long davits abaft the stern. This wheel was rotated by a system of ropes and ratchet-pulleys, driven by an atmospheric engine of the Newcomen type. It has a single cylinder 30 inches in diameter, but the double-acting principle was obtained by the interesting expedient of raising a weight, on its working stroke, equal to one-half its effective pull, and then absorbing this energy on its return stroke. Experiments were supposed to have been made on the River Avon; but, if so, they were apparently disappointing, for Hulls' schemes in this direction were entirely abandoned.



JONATHAN HULLS' TUGBOAT—1736.

Fifty years elapse before we again find tangible evidence of development on practical lines. Curiously enough the man primarily responsible for this—the first practical step in steam navigation—was a man deeply absorbed in the problem of improved methods of boat-propulsion by muscular power.

Patrick Miller, of Dalswinton, Scotland, had several vessels of novel design constructed at Leith in 1786-'87. Besides having the unusual features of twin or triple hulls, each of these vessels was fitted with man or wind-driven paddle wheels. One of the largest and most successful of these craft was a double-hulled vessel 100 feet long and 31 feet broad. Each hull was about 12 feet broad, leaving a 7-foot space between, in which were arranged, tandem-fashion, five-paddle wheels about 7 feet in diameter. Each wheel was worked by a separate capstan on deck: the quaint contemporary description of the intervening mechanism could not, perhaps, be improved upon by paraphrase. "On the lower part of the capstern was a fixed wheel with teeth pointing upwards to work in a trundle fixed on the axis of the water wheel. The diameter of this wheel is equal to 3½ diameters of the trundle, so that one revolution of the capstern produces three and one-half revolutions of the water wheel." With thirty men employed, a speed of 4.3 knots was attained. Arrangements were made for lifting the paddles out of water when under sail. This vessel is recorded to have made a satisfactory voyage across the North Sea to Stockholm in very rough weather. Windmill motors were tried by Miller, and also winches and crank-handles as alternative manual machines. An inset to the photograph of the above ship shows a number of details of the *Edinburgh*, a triple-hulled design by Miller, which was driven by two 6-foot paddle wheels.

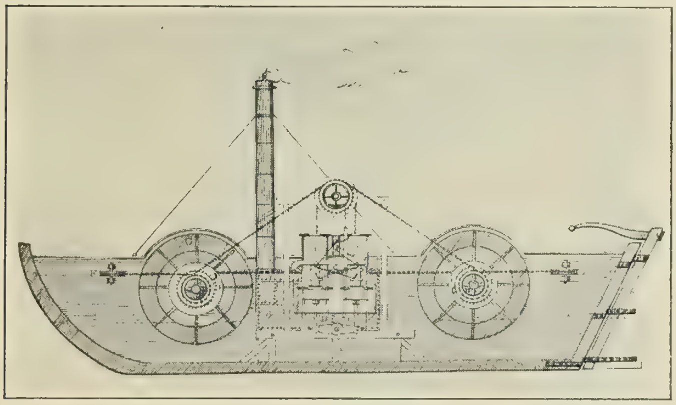


PATRICK MILLER'S DOUBLE AND TRIPLE-HULLED PADDLE BOATS.

It was while engaged in these experiments that the idea of using steam as a motive power was suggested to him by a Mr. Taylor, and with it the name of a neighboring mining engineer, William Symington, who had recently invented "a steam engine on principles entirely new." Symington was therefore approached, agreed to the proposals, and by this happy collaboration of engineer, financier, enthusiast and mutual friend, was produced the first circumstantially described and propelled steamship.

A small double-hull boat 25 feet in length and 7 feet extreme breadth was prepared by Miller, and aboard this vessel Symington's machinery was placed in October, 1788, the engines being upon one hull and the boiler upon the other. As indicated by our sectional view of this novel craft, the two paddle wheels were driven by wheels and chains and arranged one before and one abaft the driving machinery. It was an atmospheric engine having two open-topped cylinders each, only 4 inches in diameter, with a 9-inch stroke. The valve

boxes were fixed at the lower ends, and the steam and exhaust valves actuated by "tappet" mechanism. A jet condenser was used, and the air pumps, curiously formed at the lower ends of the main cylinders, were fitted with separate and inverted pistons connected by a small rocking-lever. On each paddle shaft were two loose pulleys with ratchet teeth,



INBOARD PROFILE OF SYMINGTON'S AND MILLER'S FIRST BOAT WITH THE "ORIGINAL MARINE ENGINE" INSTALLED—1788.

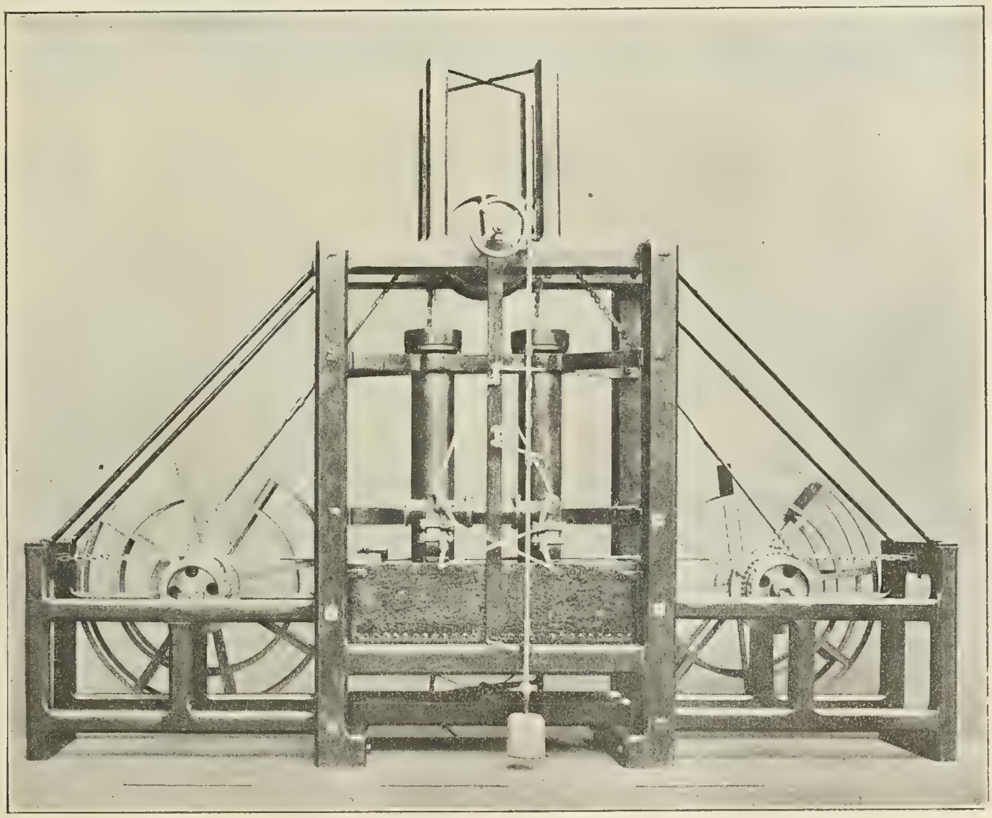
which engaged alternately with chains from the central driving drum and thus gave continuous motion in one direction.

Experiments on Dalswinton Lake with this boat were of such a character as to justify a larger equipment. In the following year, therefore, a similar set of engines, with cylinders increased to 18 inches in diameter, was made and fitted upon a much larger craft on the Forth and Clyde Canal, with the result that a speed of between 6 and 7 knots was readily obtained. At this stage, however, Miller appears to have been dissatisfied with the type of engine used, and the partnership ended.

The first set of these engines, which may fairly claim to be "the original marine engine," has been preserved in a remarkable manner. After changing ownership on various occasions and being finally condemned as scrap metal, most of the pieces were collected together by the late Bennet Woodcroft, Esq., F. R. S., inventor, and author of "The Origin and Progress of Steam Navigation, etc.," who delivered them into the hands of Messrs. Penn & Sons, the well-known engineers of Greenwich; here the engine was successfully rebuilt and again run under steam in 1854. A separate photograph of this interesting relic is reproduced: the original may be seen in the machinery galleries of the Victoria and Albert Museum, South Kensington.

In 1801, a Lord Dundas, who was largely interested in the development of the Clyde and Forth Canal, asked Symington to design and build an experimental steam tug for this service as a substitute for horse haulage. Symington accepted, and, profiting by his early experiences, as well as by the more recent advances in steam-engine details made by James Watt and contemporary engineers, produced an entirely new type of machine and, it is to be noted, attached it directly to a crank on the axis of his paddle wheel. Combining with these innovations an improved boat and paddle, he patented the whole conception in October, 1801. This was the famous *Charlotte Dundas*.

A cursory examination will convince that this engine was a remarkable step towards simplicity of construction, if it were not indeed well abreast of marine engine design for the next half-century. The hull, too, presents a not unfamiliar appearance to those acquainted with shallow-draft stern wheelers of quite recent date. As a whole, the *Charlotte Dundas* well

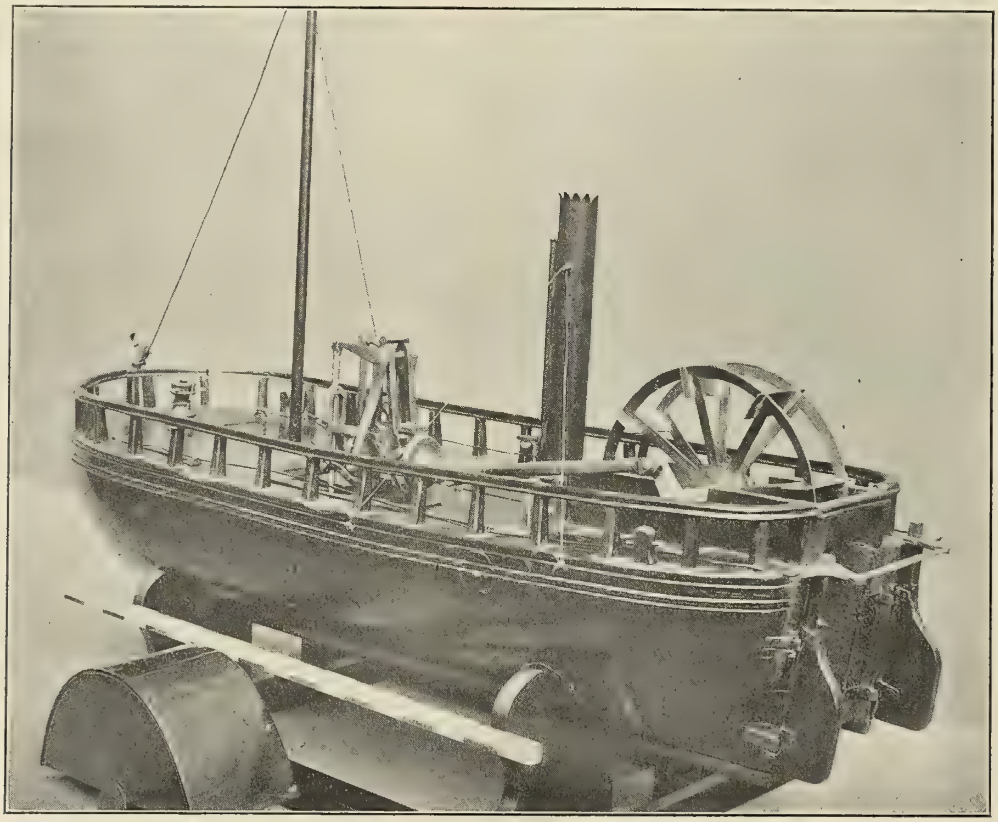


SYMINGTON'S ORIGINAL MARINE ENGINE.

justifies her claim to have been the "first practical steamboat." The machinery itself may be termed epoch-marking, as applied to this purpose—a horizontal direct-acting engine with connecting rod and crank, the lever or beam being specifically abolished; a piston rod kept in parallel motion by a roller or slide, and last, but not least, an internally-fired boiler. The

single cylinder of the engine was 22 inches in diameter, with a 4-foot stroke, and an estimated horsepower of 10. Condenser and air pump were below deck, the latter worked by a bell-crank from the cylinder cross-head.

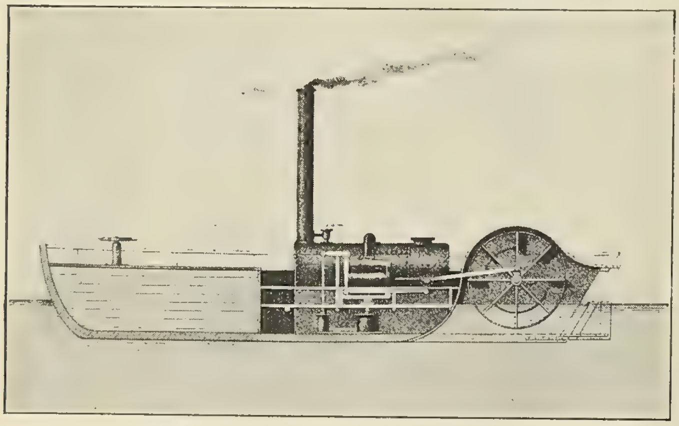
Dundas was in advance of her age, and she ended her career as a derelict in a neighboring creek. Lord Dundas, himself, however, had faith in the new system of propulsion and recommended the notion to the Duke of Bridgewater, who



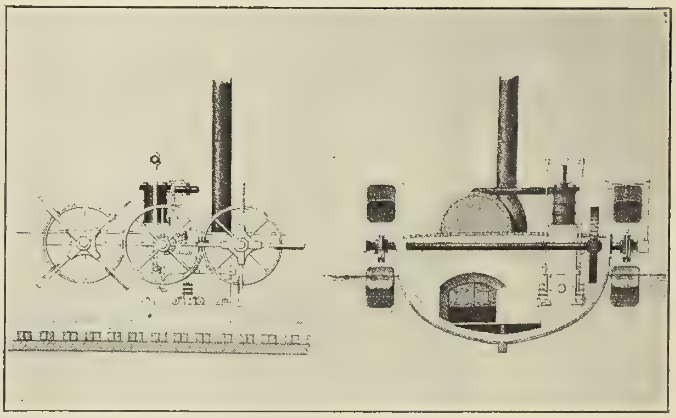
MODEL OF THE CHARLOTTE DUNDAS, SYMINGTON'S FIRST PRACTICAL STEAMBOAT—1801.

The vessel, herself, was a single hull, with two keels, and had a deep recess formed in the after portion to receive a single paddle-wheel. Separate rudders, linked together, were

promptly, in 1802, ordered Symington to build eight such boats for the Bridgewater Canal: the unexpected decease of the Duke canceled this promising development.



LONGITUDINAL SECTION OF THE CHARLOTTE DUNDAS.



SECTIONS IN THE MACHINERY SPACE OF THE COMET.

fitted to the twin sterns. Her over-all length was 56 feet and breadth 18 feet.

With all the elements of signal success, viewed from a more modern standpoint, the vessel proved a failure. Not that she failed to fulfil her designed rôle of a steam-propelled tug, for she successfully towed two loaded vessels, each of 70 tons burden, over 19 miles in 6 hours, against a strong headwind, but because of the over-anxiety of a number of canal proprietors as to damage done to the canal banks by the wash of the propeller.

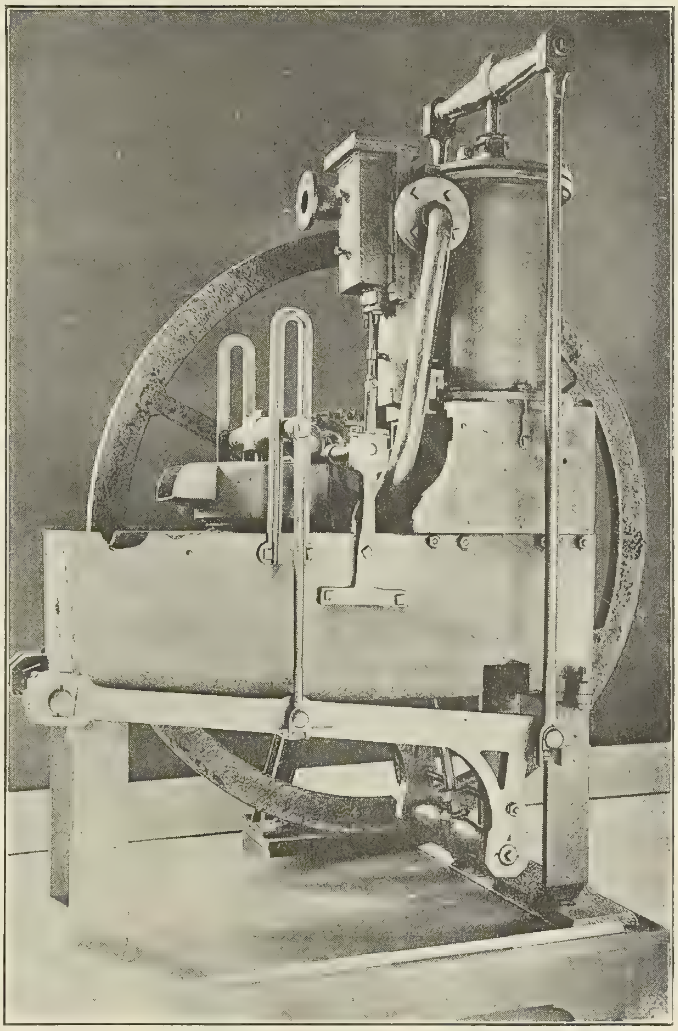
Like the *Great Eastern* of fifty years later, the *Charlotte*

Before leaving the subject of the *Charlotte Dundas* and her designer, it is worthy of remark that the original patent covered the use of side paddles on ordinary-shaped vessels; it also probably originated the idea of an "ice-breaking steamer," by proposing to use steam-driven "beaters or stampers" at the bow of the boat to force a passage in frozen waters. It is also an interesting fact that in July, 1801, Robert Fulton, the American engineer, paid a visit to Symington, took an 8-mile trip in his boat, asked many questions and made notes and sketches of her design.

Although British enterprise had thus so far taken the lead

in steamship development, its horizon seemed strictly bounded by the towage tradition, and imagined no possibility of a passenger or general shipping traffic. This important step, however, was successfully made by Messrs. Fulton, Livingston & Stevens, during the next decade, in America. It was largely under this stimulus that commercial steam navigation took permanent shape in Europe by the historic *Comet*, inaugurating a passenger service on the Clyde in January, 1812. The boat was built by Messrs. Wood & Co., at Port Glasgow, for Henry Bell, and carried goods and passengers between Greenock and Glasgow. She was of 30 tons burden, 40 feet long, 10.5 feet broad, and, with only 4 horsepower, averaged a speed of about 6 knots.

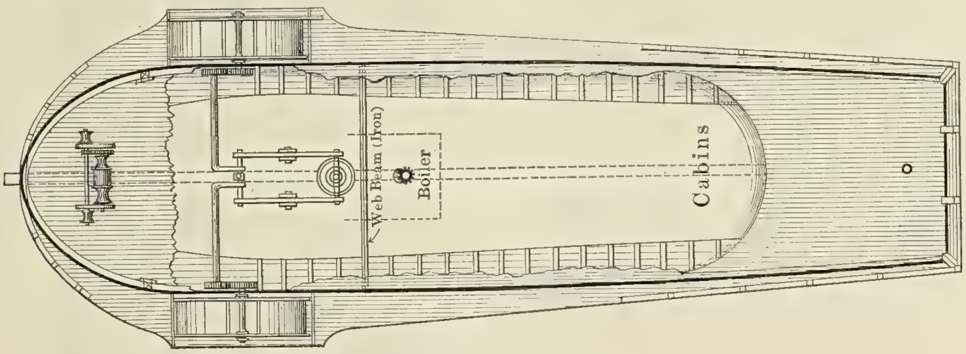
Her engines were made by Robertson, of Glasgow, and show a single, upright cylinder 12.5 inches in diameter and 16 inches stroke. This was placed over the working shaft, but drives it by means of two long side rods, which link the cylinder cross-head with two half side-levers joined by an underneath cross-head, which carries a connecting rod acting upwards on an overhanging crank. It should be noted that the fulcrums of these rocking-levers are not at their centers, but at the extreme ends of the arms. This, known as the "grasshopper" type of lever engine, has had considerable vogue for tugboats down to the present day. Uniform motion is given to the crankshaft by a weighted fly-wheel 6 feet in diameter, and the paddle shafts are driven by spur gearing, which reduces the relative speed of paddles by nearly one-half. It is recorded that sometimes, when the small-powered engine showed signs of distress, the passengers would render temporary assistance by turning the fly-wheel. A balanced rocking shaft worked by an eccentric actuates the slide valve. Water tank and condenser form portions of the main engine casting, and inside the tank is the air pump, worked from the side levers. The boiler is externally-fired and set in brickwork. Side paddles and projecting "guards" give the vessel a very modern appearance: originally, two paddles each side, with detached arms, were used, but these were eventually changed to one complete wheel on each side. A lofty funnel served the purpose of a mast, and the vessel is often depicted in contemporary sketches with a large square sail hoisted.



ENGINE OF THE COMET, BUILT IN 1812.

The *Comet* initiated pleasure cruises around the British Isles, and also ran regularly for some time on the River Forth. She was wrecked in 1820.

Once started, the idea of steam river boats grew apace, and within the following four years there were no less than ten paddle steamers plying in the Clyde alone. One of the oldest survivors of these pioneer boats was the *Industry*, built in 1814 by W. Fife, grandfather of the famous yacht designer. After sixty years' service in the Clyde, she was laid up on the river bank, and remained an object of interest to passing visitors as late as 1890. Her deck plan, which we reproduce, is typical of practically all these earlier steamers—a full bow, with paddles placed well forward, and light "guards" extending the available deck space at the sides. The original engines were probably similar to those of the *Comet*, but were replaced by a new set in 1826; these latter were removed from the old hulk and shown at the Glasgow International Exhibition of 1888, and now have a permanent resting place in Kelvingrove Park, Glasgow. They comprise a single cylinder 16 inches in diameter and 24-inch stroke, driving two ordinary side levers. Spur gearing gave the engine a mechanical advantage of about 4:3 in this instance. A certain amount of grinding noise was inevitable in these geared engines, and earned for them the sobriquet of "coffee mills"; they never-

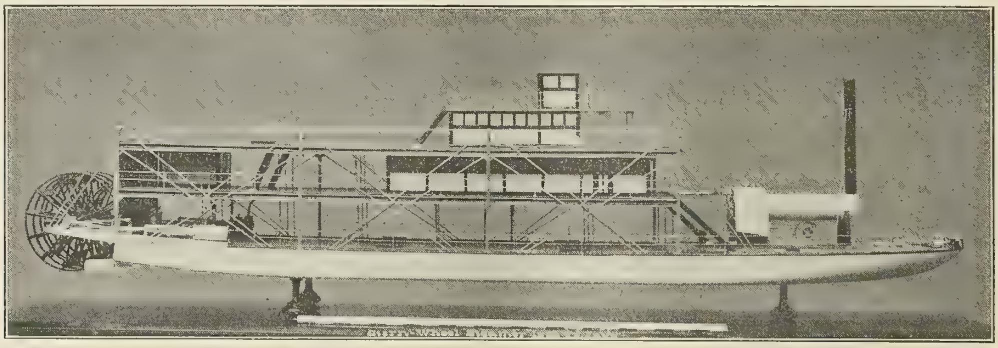


DECK PLAN OF INDUSTRY (1814).

theless were popular for many years, one of the first successful coasting steamers, the *James Watt,* of 100 horsepower, being fitted with them as late as 1822.

The accompanying photograph of the shallow-draft steamer *Inez Clarke,* built by Messrs. Yarrow, in 1879, for South America, is at present the most popular type for inland navigation throughout the world. She obtained a speed of 15 knots on a draft of 15 inches. Some twenty of these craft were constructed for the British military expedition up the Nile in 1885.

As may be readily noted here, we have the conceptions of Hulls and Symington—stern wheel, horizontal engines and multiple rudders—perfected. The modern development in general structural design of the hull is perhaps more marked in character than that of the machinery arrangements.



INEZ CLARKE (1879), THE MODERN DEVELOPMENT OF HULL'S AND SYMINGTON'S CONCEPTION.

THE FIRST STEAM SCREW PROPELLER BOAT.*

The steam screw propellers of Col. John Stevens, in operation on the Hudson River from 1802 to 1806, were the first to be used in steam navigation in any country.

Col. Stevens cannot, however, be considerd the inventor of the screw propeller for the propulsion of vessels, for this device was proposed by the methematician, Daniel Bernouli, in 1752, and it was also described by David Bushnell in 1787, although Bushnell's propeller was operated by hand. The same idea was afterwards suggested by Franklin, Watt and others. Previous to 1802 the screw propeller was twice patented in England, but the propeller was not driven by a steam engine.

The first application of steam to a screw propeller was made by John Stevens on the Hudson in the year 1802. The engines that he tried in 1802, 1803 and 1804 were all non-condensing, and the boilers were all multi-tubular, using high-pressure steam. The propeller was a short, four-bladed screw.

The engine which Col. Stevens used in 1802 was constructed on the rotary principle, to avoid the bad effects of the alternating strokes of engines of the ordinary construction. The cylinder was of brass, about 8 inches in diameter and 4 inches long. It was placed horizontally on the bottom of the boat, and by the alternating pressure of the steam on two sliding wings, an axis passing through its center was made to revolve. This axis, or shaft, passed through the stern of the boat, and on its outer end the propeller was fastened. This constituted the whole of the machinery. Working merely with the elasticity of the steam no condenser or air pump was necessary, and as there were no valves no apparatus was required for opening and closing them.

This engine was installed in a flat-bottom boat 25 feet long and about 5 or 6 feet wide, and a speed of about 4 miles an hour was obtained. Difficulty in keeping the packing of the wings in the cylinder tight for any length of time led Col. Stevens to resort again to the reciprocating engine, and in the following year, 1803, he constructed a small reciprocating engine and installed it in the same boat, driving the shaft by means of bevel gears. A somewhat greater speed was obtained with this than with the rotary engine.

In 1804, Col. Stevens achieved his most successful results with early screw-propeller steamboats. His boat was 25 feet long and 5 feet wide, and was fitted with twin screws, driven by a Watt engine having a cylinder 4½ inches in diameter with a 9-inch stroke. The beam was omitted; the boiler was 2 feet long, 15 inches wide and 12 inches high, containing eighty-one tubes, each 1 inch in diameter. This boat was successfully operated in the Hudson River in May, 1804, obtaining a speed of about 4 miles an hour. Due to accident, it was necessary to replace the boiler, and the next one was constructed with the tubes placed vertically. Under certain conditions it was possible to obtain a speed of 7 or 8 miles an hour with this boat. The illustration shows the original boiler and engine used in this boat, which is now on exhibition at the Stevens Institute, Hoboken, N. J.

Col. Stevens' plan for working twin screws by a single cylinder is the most simple one that could be devised. The reaction of the connecting rods against each other at their junction with the piston rod acts as a parallel motion to keep the rod in alinement, performing the same office as slides. When the screw propeller came into use after a lapse of nearly forty years, this plan of a single cylinder for twin screws was revived, both in America and abroad, being known in France as the Etoile engine. The valves on this twin-screw engine are formed by two-way cocks, a modification of the single-way cocks used by Savery and Newcomen, one cock at each end of the cylinder answering both for the admission and the exhaust of steam. The valve motion was derived from a crank on the inboard end of one of the propeller shafts. This crank worked a rack, the teeth of which meshed into those of the wheels on the plugs of the two-way cocks, this motion being similar to the toothed rack and segment of a wheel used by Watt in one of his first engines to raise his conical valves.

The boiler is one form of the multi-tubular boiler invented by Col. Stevens. It has twenty-eight copper tubes, each 1½ inches in diameter and 18 inches long; fourteen tubes projecting from each side of a rectangular chest. The grate is placed at the end of one set of tubes, and the flame passes around these tubes and then under the chest and around the tubes at the other end to the smokestack.

Some of Col. Stevens' ideas relative to his screw propeller were set forth in an interesting letter to Dr. Robert Hare, of Philadelphia, Pa. In describing the propeller he said that to the extremity of an axis passing nearly in a horizontal direction through the stern of a boat is fixed a number of arms with wings like those of a windmill or smoke-jack. These arms are made capable of ready adjustment, so that the most advantageous obliquity of their angle may be obtained after a few

* Abstract from an article by Francis B. Stevens, in the *Stevens Indicator,* April, 1893

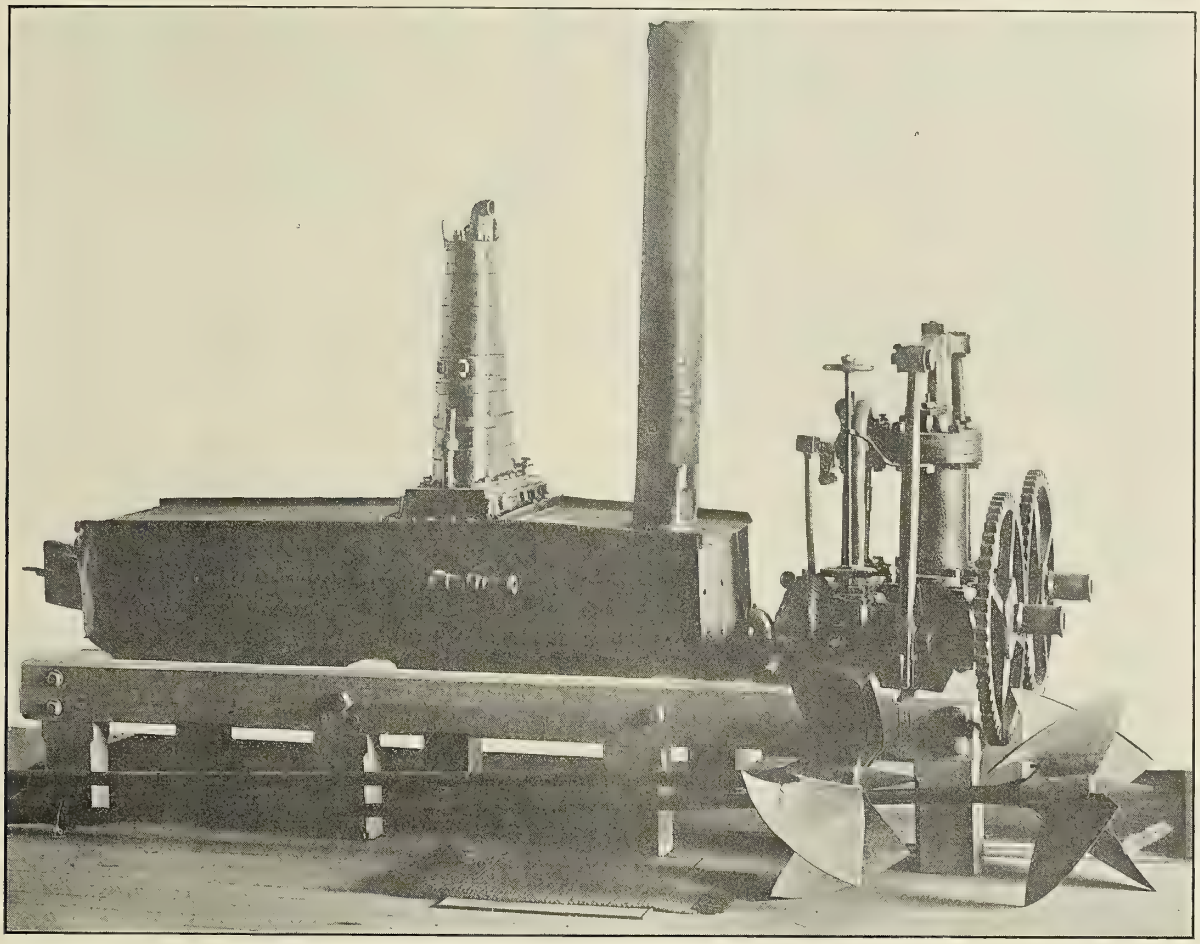
trials. He evidently expected to utilize propellers in shallow-draft boats by increasing the number of the propellers, and, consequently, diminishing their diameter. He stated that it was absolutely necessary to have at least two propellers revolving in opposite directions, to prevent the tendency to rotation which a single wheel gives to the boat. Lack of efficiency in the propeller he accredited partly to the fact that the proper angle of obliquity was not attended to, and to the fact that the wings were made with a flat surface, whereas a certain degree of curvature was necessary.

At the date of the introduction of the screw propeller commercially, the pressure of steam carried on the boilers of condensing engines of the vessels that then navigated the bays and rivers of the Atlantic seaboard averaged about 30 pounds per square inch, while on Western river steamboats the pressure averaged 140 pounds. At the same date the steam pressure on English vessels was virtually the same that Watt had established, namely, 2½ to 3 pounds per square inch. The *Great Western* in 1838 carried that pressure, and the iron screw propeller *Great Britain* in 1864 carried only 5 pounds pressure.

Col. Stevens' attempts to introduce steam navigation by the screw propeller lasted for six years, and were relinquished only one year before the successful application of the paddle-wheel by Fulton. The five distinct improvements he proposed were: First, the short, four-bladed screw propeller. Second, the use of high-pressure steam. Third, the multi-tubular boiler. Fourth, the quick-moving engine, direct connected to the propeller shaft. Fifth, the use of twin screws. None of these improvements were applied to steamships for forty years thereafter, and yet all are elements in the success of ocean navigation at the present day.

An inspection of the rude workmanship of the twin-screw engine, as well as that of the boiler, will explain the reasons for the abandonment by Col. Stevens of his plan of screw propulsion. There were no tools or workmen in America at that date competent to properly construct such machinery, and, therefore, success was impossible. Realizing this, Col. Stevens turned his attention to the paddle-wheel, with its slow-moving engine, and with the boilers then in use carrying steam at pressures of 2 or 3 pounds above the atmosphere. He was engaged in building the *Phoenix* when Robert Fulton arrived from Europe with the engine made for him by Watt in 1806, which, complete in all its details, and, in these respects, far in advance of any engines that could then have been built in this country, achieved success.

The paddle steamboat *Phoenix* was completed a few weeks after Fulton's *Clermont*, but, as she was debarred from navigating the Hudson River by the monopoly given to Fulton by the Legislature of the State of New York, she was sent by sea to Philadelphia, and the *Phoenix* was, therefore, the first steamboat to navigate the ocean.



BOILER, ENGINE AND PROPELLERS OF COL. JOHN STEVENS' FIRST SUCCESSFUL STEAMBOAT.

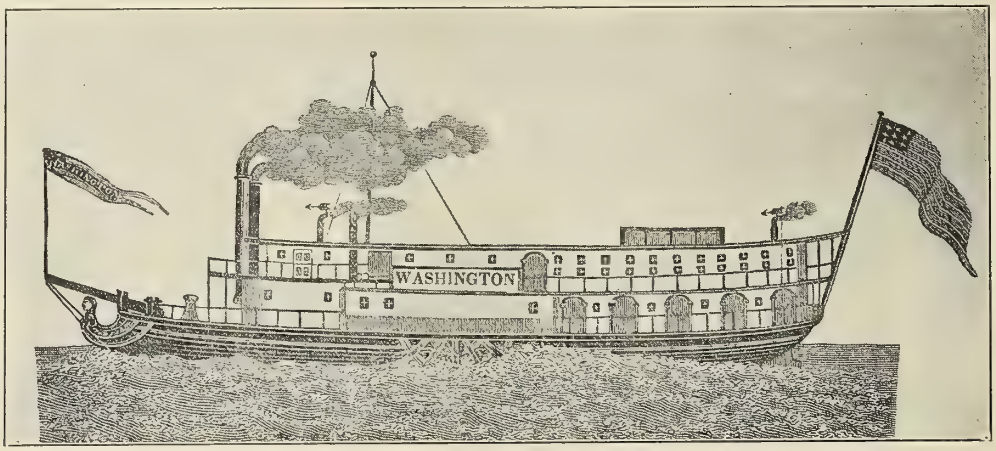
The first steamship to cross the Atlantic Ocean was the *Savannah*, built in 1818 at New York City by Francis Fickett. The vessel was about 100 feet long, 28 feet beam and 14 feet deep. She was originally constructed as a sailing packet for the New York & Havre Line, but she was purchased by Scarborough & Isaacs, of Savannah, Ga., and fitted with an engine, boiler and paddle-wheels. The engine was of the inclined type, built by Stephen Vail, of Speedwell, N. J., and the boiler was built by Daniel Dod, of Elizabethtown, N. J. The paddle-wheels were 16 feet in diameter, with eight radial buckets on each wheel, so constructed as to be folded up like a fan. The *Savannah's* first trip across the ocean was from Savannah, Ga., to Liverpool. The voyage was accomplished in twenty-seven days, eighty hours of which the vessel was operated under steam.

THE DEVELOPMENT OF WESTERN RIVER STEAMBOATS.

BY CAPT. T. M. REES.

The first steamboat to ply on the Western rivers of North America was the *New Orleans,* built at Pittsburg, Pa., by Livingston & Fulton, under the supervision of Nicholas J. Roosevelt, in the year 1811. It was 116 feet long, 20 feet beam, with about 7 feet depth of hold, fittted with a low-pressure engine having a cylinder 34 inches in diameter. Propulsion was by means of side-wheels. There were two cabins, one forward for men and one aft for women. The boat was also fitted with two masts and sails, as, at that time, Fulton thought sails might occasionally be useful. The cost of the boat was about $38,000 (£7,810).

The *New Orleans* made her maiden trip in September, 1811, and was regularly employed to carry freight and passengers on the route between Natchez and New Orleans. During the night of July 14, 1814, while a few miles above Baton Rouge, La., she grounded on a stump while the water was falling. On endeavoring to free the boat, she sprung a leak and sank.



STEAMER WASHINGTON, BUILT IN 1814. (FROM AN OLD PRINT.)

STEAMER DEAN ADAMS, A TYPICAL MISSISSIPPI RIVER BOAT.

The next steamboats built for service on Western rivers were the *Comet,* 50 tons, in 1812, which was built from a barge; the *Buffalo,* 250 tons; *Aetna,* 361 tons; *Vesuvius,* 390 tons, and the *Enterprise,* 75 tons, all built in 1814.

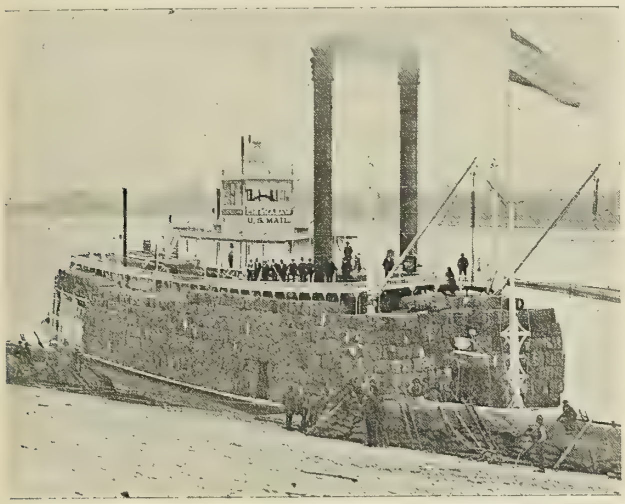
The first two-deck steamboat with cabins between the two decks was the *Washington,* 148 feet long, built in 1814, under the supervision of Capt. Henry M. Shreve. She was also the first boat to have boilers with flues on the main deck, and her engines were the first high-pressure engines used. They were also the first engines placed in a horizontal position, giving vibrations to the "pitman" or connecting rod, besides being the first to use a cut-off cam to secure the benefit of the expansion of the steam.

The hulls of steamboats up to about 1830 were of heavy construction like a sailing vessel. As some of them were fitted with bowsprits and figureheads they had to be handled very cautiously in making landings to avoid damage to themselves or any other boats at the landings. The largest boat built up to 1832 was the *Mohawk,* whose tonnage is given as 555.

The method used on Western river steamboats to supply feed water to the boilers up to 1843 consisted of side pumps, direct connected to the main engines. The main engine shaft was connected to the wheel shaft by a clutch, which could be disconnected by a very strong lever. When the boat was stopped, and it became necessary to supply water to the boiler, the shafts were disengaged by throwing the clutch out of gear, the engines at that time all having large, heavy fly-wheels. This method of supplying water to the boilers was used until 1843, when a horizontal pump, called the "wheel-barrow pump," was made by James Rees, which worked independently from the main engines. The first boiler-feed pump of the type known on Western rivers as the "doctor," was built for the steamer *Missouri.* As is well known, the "doctor" has two cold-water pumps and two hot-water pumps. Water is taken direct from the river through the side of the boat by the cold-water pumps and passed through the heater, where it is heated by the exhaust steam, after which it is passed into the hot-water pumps, where it is acted upon by plungers and forced directly into the boilers. The original "doctor" was operated on one bed-plate with columns and a beam connected to the cylinder, with cross heads, slides and fly-wheel. The second pump of this type was built with a parallel motion, doing away with the slides, and was placed on the steamer *Hibernia II.*

The name "doctor" was given to this pump by engineers at that time because they claimed that it doctored all the ex-

isting evils by giving a steady supply of feed water to the boilers. Under all conditions of steam pressure, and with sandy or muddy water, this pump never failed, and it is known to this day in all parts of the world as one of the very best and safest pumps that can be put on a steamboat for river navigation. The first beam doctors were built by Messrs. Stackhouse & Nelson, engine builders, Pittsburg, Pa.

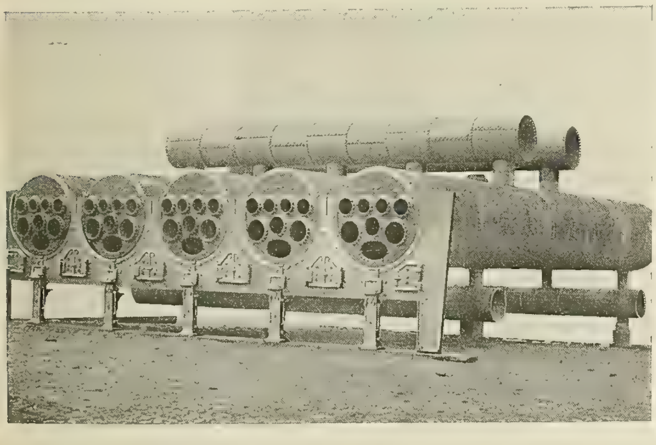


STEAMER CHICASAW, SHOWING METHOD OF LOADING COTTON.

Another invention was made about this time which showed that Western river boatmen were alive to their best interests. In the year 1843 the steamer *Clipper* was built with two steam cylinders, one high-pressure cylinder exhausting into a low-pressure cylinder, which was separated from the high by a distance piece. From the low-pressure cylinder the steam was exhausted into the heater and then outboard into the air. These engines would be called compound engines at this time, but were then known by Western river men as the Clipper engine, the name being taken from the steamboat on which they were first installed. They were built by Mr. Thomas Litch, engine manufacturer.

In 1854-1855 six steamboats were built which had twin stern wheels, with four engines so connected that the wheels could be operated separately, so that one wheel could be turned ahead while the other was going astern, thus facilitating the handling of the boat. These six boats were the *Challenge*, built in 1854, and the *Adriatic, Alma, William Baird, Aunt Lettie* and *North Star*, built in 1855. It is believed that these were the first boats ever built with twin wheels at the stern. It is now thought by some of the oldest and best steamboat men that by giving the modern Mississippi River boats, capable of carrying 4,000 or 5,000 tons of freight, the length and breadth of beam necessary to return to the twin wheel and four engines, and by making the pair to each wheel cross-compound, and by using balanced rudders, the Mississippi could be navigated safely on the present depth of water in the river without obtaining the 14-foot draft which is so earnestly advocated by the people of the Mississippi Valley.

STEAMER J. N. HARBIN, A TYPICAL LIGHT-DRAFT COTTON BOAT.



EXTERNALLY-FIRED FLUE BOILERS USED ON WESTERN RIVER STEAMBOATS.

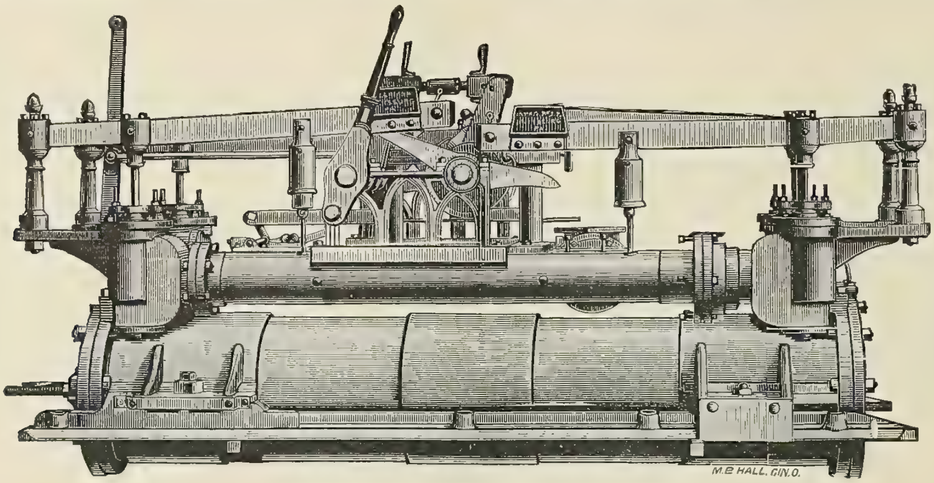
An idea of the growth and decline of steamboat building on the Western rivers can be obtained from the following record of the number of boats built annually in the Pittsburg district, which includes Brownsville:

Year.	Number of Boats Built Per Year.
1811	1
1812	1
1814	4
1816	1
1817	4
1818	7
1819	8
1823	6
1825	9
1825-1830	12
1830-1835 about	30
1835-1840 "	35
1840-1845 "	40
1845-1850 "	50
1864	80

Since 1864 there has been a steady decline, until now the number seldom reaches more than two or three per year.

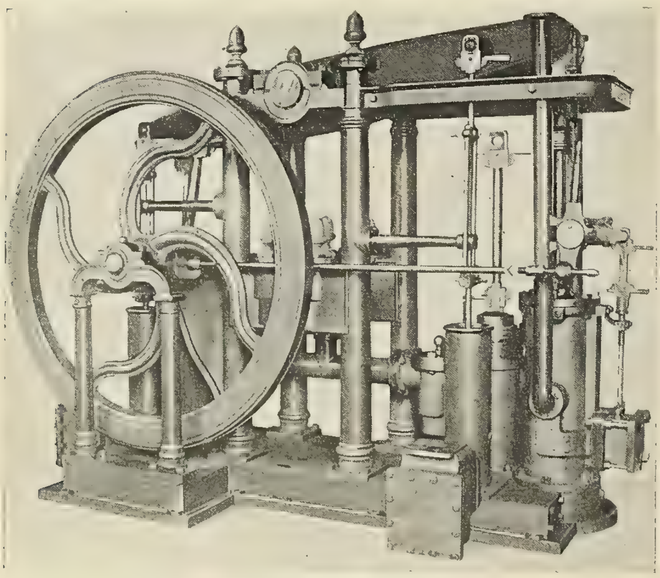
The finest packets were run during the years 1845 to 1870. After the latter date the railroads cut in on the passenger traffic, and boats were then built principally for freight capacity. As an example of what freight boats were capable of doing at that time the steamer *Paragon*—built at Pittsburg in 1873, of the following dimensions: Length, 265 feet; beam, 48 feet; engines, 22½ inches diameter, 8 feet stroke; five boilers, length, 26 feet, diameter 40 inches, each having two 15-inch flues; paddle-wheel, diameter 26 feet, length of bucket 28 feet, width of bucket 36 inches—made a trip from Cincinnati to Wheeling, a distance of 370 miles, in forty-seven hours, carrying 1,450 tons of iron ore, with a depth of 6 feet of water in the river. On another occasion she averaged a speed of 10 miles per hour from New Orleans to Cairo, carrying 1,000 tons on a draft of 5 feet forward and 4 feet 9 inches aft.

The towing of coal to the lower ports, which commenced about 1850, brought forth another type of boat with barges, which increased the tonnage of boats in Pittsburg, until in 1901 it exceeded in registered and unregistered vessels the tonnage of New York by over 818,000 tons. The capacity of these towboats increased from 50,000 bushels in 1855 to 300,000 bushels in 1900. This increase was made notwithstanding the fact that in recent years the channels in the rivers have been artificially obstructed by bridges, the distance between piers in many cases being less than one-third the width of the river, which was formerly available from bank to bank. The increase is due largely to the experience of the crews, the use of improved machinery and improvements made in the boats and rudders, as it was about this time that the balanced rudder came into use for stern-wheel boats. As ordinarily used, the forward end of the balanced rudder extends under the stern rake of the boat, having about one-third of the rudder forward and two-thirds aft.



A HIGH-PRESSURE POPPET VALVE LEVER ENGINE.

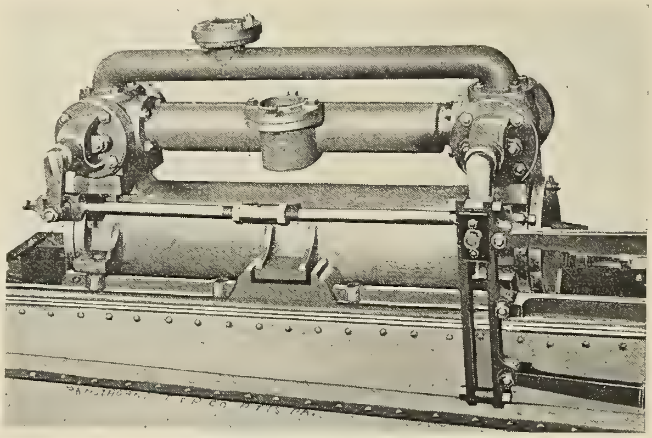
The method of towing on the Western rivers is quite different from that used on the Great Lakes, or on the coast or in foreign countries. The barges are all placed forward of the towboat, lapping not more than one-third on the forward end of the boat. When the entire tow is properly made fast, the boat is like a single huge rudder to the tow. This method of towing is now being adopted on other rivers, notably the Yukon.



"DOCTOR" PUMPING ENGINE.

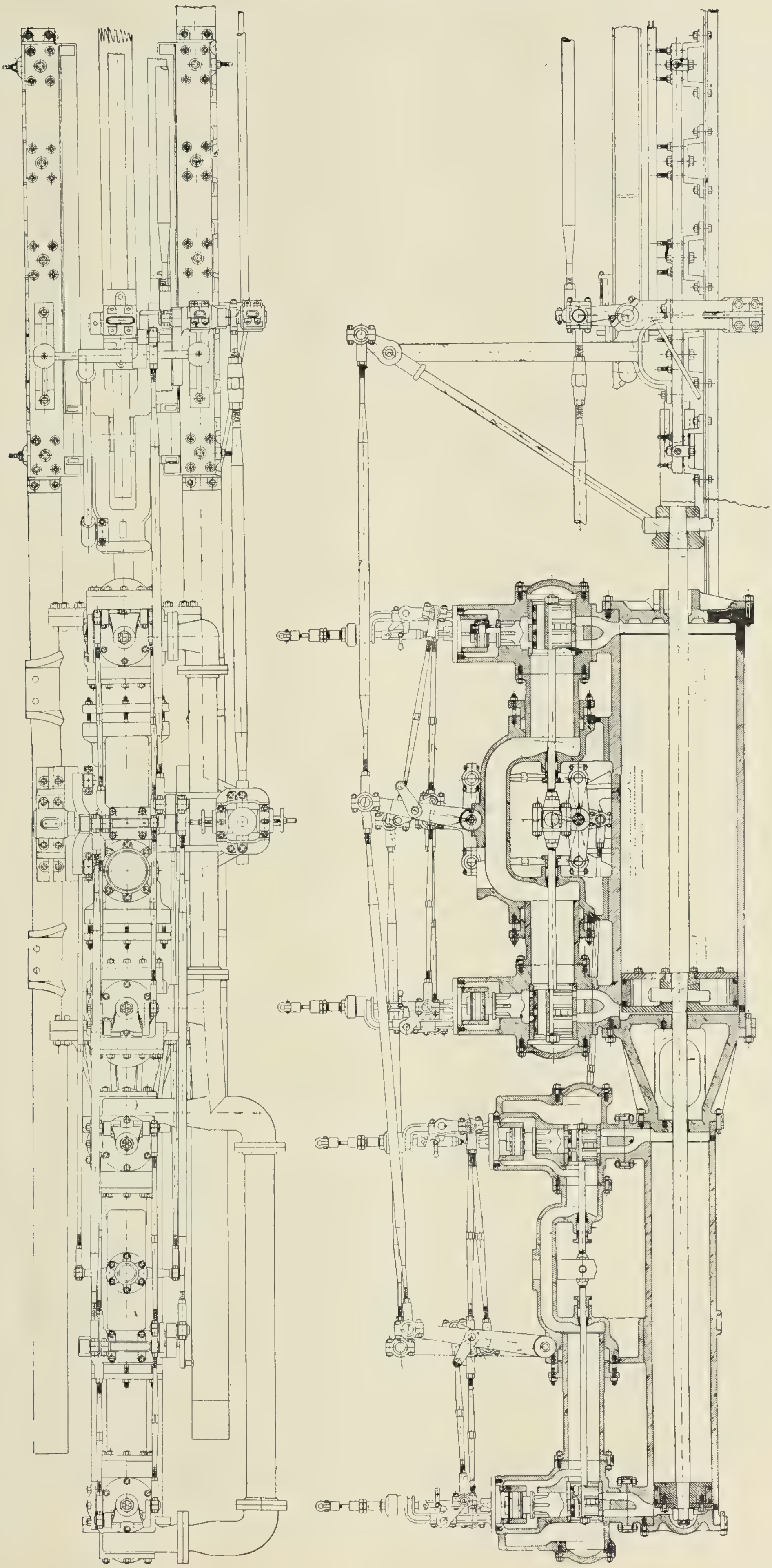
Almost all styles of naval architecture have been used in the construction of Western river steamboats. In 1855 a stern-wheel boat was built with the rudder at the bow. A number of boats with a recessed wheel have been built, called "bootjacks"; also twin hulls have been used, joined together to form a catamaran, with the wheel in the center. The tunnel boat and the cone propeller have also been used, but so far no design has excelled the stern-wheel boat for shallow river navigation. In competition with side-wheel boats, where navigation was difficult, the stern-wheel boats entirely drove the side-wheel boats from the trade, particularly in rivers like the Missouri, since with their spars set and the wheel at the stern they were able to pass over bars over which it was impossible to pass with side-wheel boats.

Shallow draft stern-wheel river steamers of the type developed on the Western rivers are now being used in India, Russia, Manchuria, China, Africa and South and Central America. In 1878 the first steel steamboat was built knocked-down for shipment in sections, and the first all-steel hull steamboat built on the Western rivers was the *Chattehooche,* built in 1881.

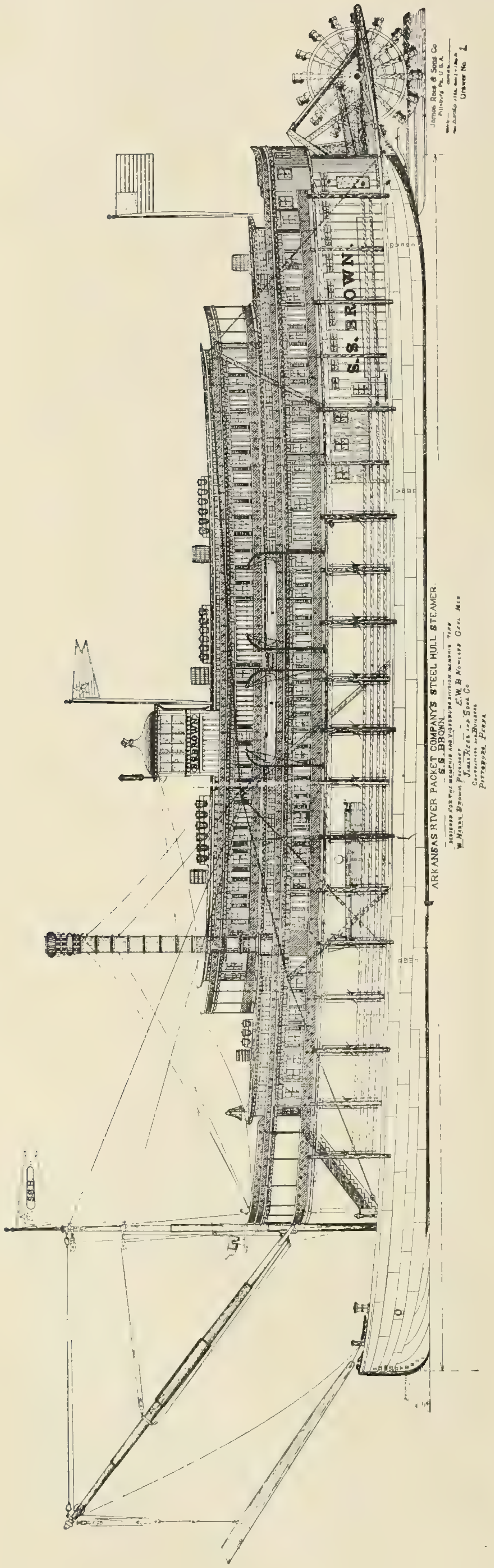


A HIGH-PRESSURE ROTARY VALVE ENGINE.

Among the auxiliaries which are distinctive on Western river steamboats is the steam capstan, working with independent engines, which came into use in the year 1855. This was designed by an engineer named Jack Schaffer, and was built by Robert Rogers, who was also builder of the Rogers hand-capstan. Formerly, when boats were aground, the hand-capstan was turned by the negro deck crew, as most of the



ARRANGEMENT OF TANDEM COMPOUND ENGINES ON STERN WHEEL WESTERN RIVER STEAMBOATS.



STEEL HULL STEAMER S. S. BROWN, TYPICAL MODERN WESTERN RIVER STEAMBOAT.

deck crews on Western rivers at that time were composed of negroes, and, consequently, when the capstan was connected to an engine the engine was thereafter known as the "nigger" engine, because it did the work of the negro crew in hoisting freight from the hold and turning the capstan. The "nigger" engine was a small, single-cylinder engine, located between the main hatches forward, and was connected to the hoisting drums for each hatch as well as with the capstan. There was a reversing valve on the engine. About the same time a reversing apparatus was applied to the main horizontal engines on stern-wheel boats by James Rees.

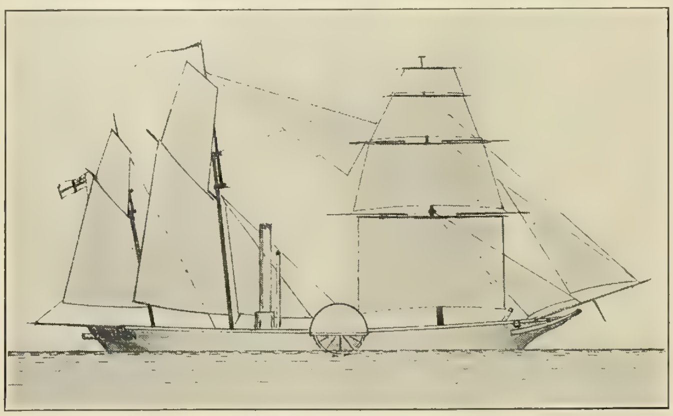
The engines that have been in use for many years past are the horizontal slide valve engine with poppet cut-off; the lever poppet valve engine, the valve being made single, and the relief and double balanced, which developed from the single-side pipe to that of the double, with an expansion joint on engines over 5-foot stroke. Although piston valves in various forms, with cut-offs both inside and outside, have been used, since 1876, however, the double-balanced valve lever engine has been accepted for the best work. Many improvements have been made on this engine. In 1870 James Rees improved it by a patent adjustable or variable cut-off, which did away with the cut-off cam by taking the motion from the cross head. Mr. John Evans, engineer, designed the full-stroke inside cam motion, which was used in the year 1882, and which has since been used by others, until now all modern boats built at Pittsburg do away with any cams whatever on the water-wheel shaft, taking the motion from the cross head or connecting rod. Indicator cards taken from these engines show an almost perfect diagram.

The compound, the cross-compound condensing and non-condensing engines are in use on tow-boats and passenger boats on the rivers.

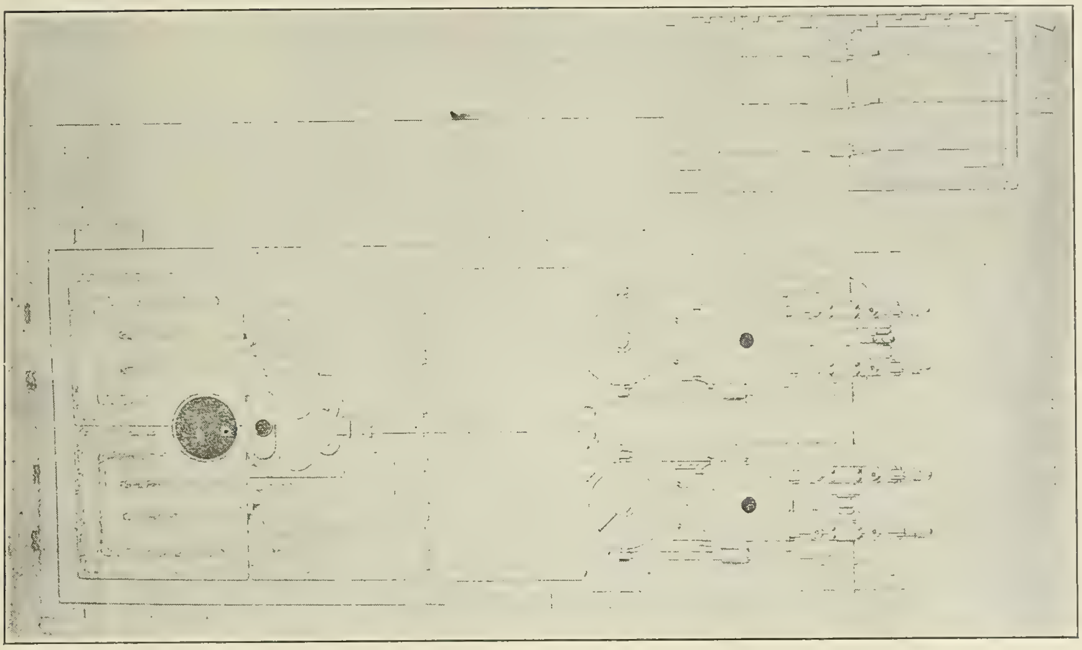
The boiler which gives the greatest satisfaction is the horizontal tubular boiler, set in an iron casing, with from two to ten flues, as may be desired, although the locomotive, the Scotch, the watertube and almost every conceivable type of boiler has been tried. Up to the present time, however, nothing has been found that fully meets all the requirements of the service as does the horizontal externally-fired tubular boiler.

EARLY WAR STEAMERS.

One of the earliest well-authenticated records of a steam-propelled vessel engaged in actual warfare occurs among the detailed despatches of the First Burmese War, in 1824-'26. Although this was primarily a punitive expedition of the Honorable East India Company to Rangoon, the company's fleet was assisted by British ships and officers during the prin-



STEAM FRIGATE PHŒNIX (1830).



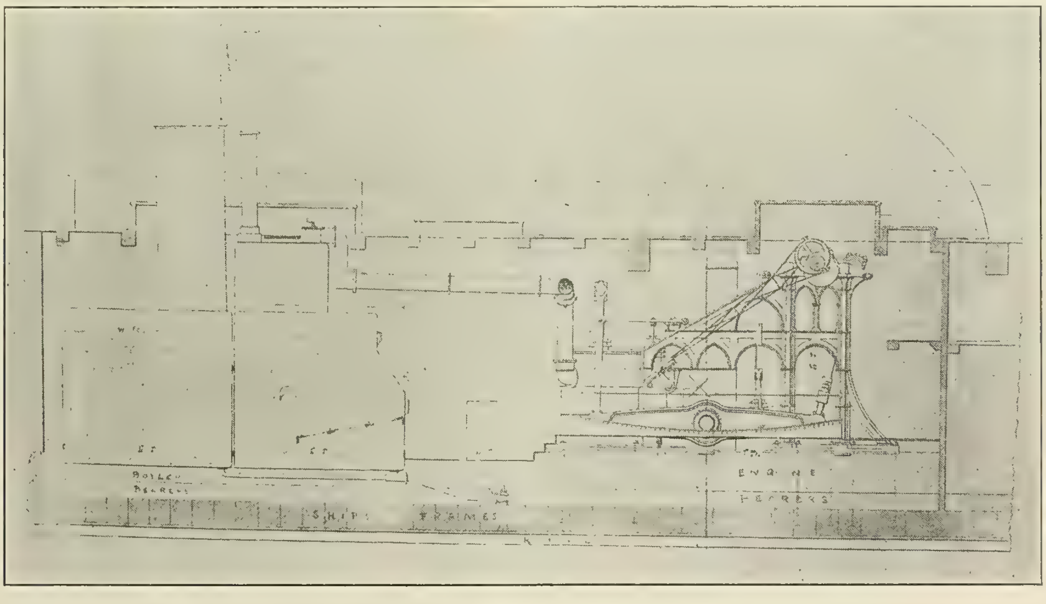
PLAN VIEW OF ENGINES AND BOILERS OF THE PHŒNIX.

cipal operations. Indeed, to Captain Marryatt, the famous novelist, who commanded H. M. sailing frigate *Larne* during the early stages of this campaign, must be awarded the credit, not only of first suggesting, but of successfully adopting steam as an auxiliary to naval tactics. Finding a small paddle steamer, *Diana,* at Calcutta in 1823, he urged her inclusion in the attacking fleet, and this vessel actually took part in the military operations of the following year.

The *Diana* proved an indispensable adjunct to the expedition, and frequent references are made to her use for reconnoitering purposes, transport of troops and towing vessels off the shoals. She is described as "unarmed," although on one occasion she "kept up a well-directed fire of rockets," and on another, "by skilfully decreasing and increasing her steam, he (the captain) wholly baffled the barbarians' calculations of her speed, till he got them within reach of her carronades and musketry." That her machinery was not free from breakdowns, may be inferred from the frequent entries in the log of the *Larne* of sending "carpenters and sailmakers to *Diana.*" It may also be readily surmised that skilled mechanicians were scarce in those days, and one log-entry—after recording an injury to the leg of the *Diana's* engineer—laconically adds "Took steamboat in tow and made all sail."

The origin and dimensions of this noteworthy vessel are somewhat obscure. She is mentioned as drawing 6 feet of water, and of being rather smaller than the *Enterprize,* a vessel 122 feet long by 27 feet broad, and of 470 tons and 120 horsepower. Further, as this latter craft is credited with the first voyage from London to Calcutta under steam, in 1825, it is probable that the *Diana* was built in India about 1822: this surmise is bound up with the fact that the *Snake,* a small river steamer, was really constructed at Bombay, in 1820. Curiously enough, both the *Snake* and *Enterprize* appear to have rendered some services during the Burmese War. These events, however, have no direct bearing upon the attitude of the British Admiralty proper towards steam-propelled warvessels.

From Viscount Robert Melville, friend of Pitt, and First



LONGITUDINAL SECTION OF THE ENGINES AND BOILERS OF THE PHŒNIX.

Lord of the Admiralty for many years, came the decision to introduce steam propulsion into the British Navy, and in 1815 the first steam sloop *Congo* was ordered for experimental purposes. When one reflects that the historical Clyde-built *Comet* was scarcely three years old, and that but two small passenger steamers had that year—after much local opposition—commenced to ply on the Thames, this would appear to have been a remarkably progressive step for a navy board still flushed with the triumph of the old order of things at Trafalgar.

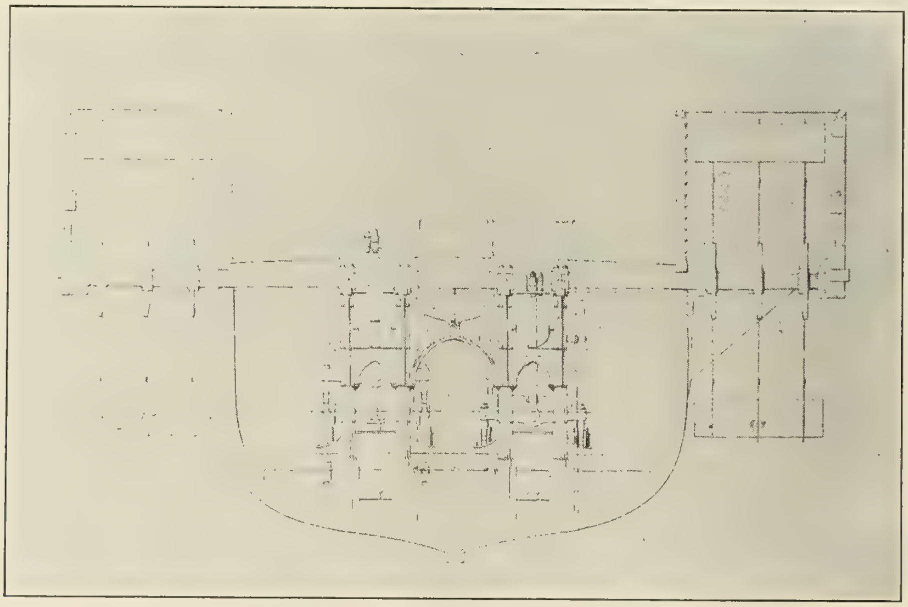
The *Congo* was built, but fitted out as a sailing vessel, while her engines, by Messrs. Boulton & Watt, Birmingham, were sent to Plymouth dockyard for pumping water. This, perhaps, is an unique instance of engineering atavism.

Six years afterwards, largely influenced by the elder Brunel, Lord Melville again essayed the problem and in 1822 had the satisfaction of seeing H. M. S. *Comet*—the first government-built steamer in the navy—ready for sea. She was constructed at Deptford, under the supervision of the celebrated Oliver Lang, and measured 238 tons. Actual drawings of her engines are not available, but they were of the side-lever type of 80 horsepower, with cylinders of 39.5 inches diameter, and stroke 42 inches. Flue boilers were used, and the paddle-wheels were 14 feet in diameter.

During the next few years most of the Admiralty designers tried their 'prentice hands at steamship work. These craft, though built for the navy, carried little or no armament, and were chiefly used for towing large vessels in or out of harbor, for coastal voyages between home dockyards, or for occasional mail service to Gibraltar and Malta. Beyond, however, a progressive increase in dimensions and horsepower, they all had very much in common, and the side-lever engine, made by all the principal contracting firms, was practically universal. As typical of this period we have reproduced details of the hull, boilers and engines of the *Phoenix,* and her sister ships *Rhadamanthus* and *Salamander,* built at various yards during the years 1827-'30.

These "steam frigates" had the following principal dimensions: Length over all, 200 feet; breadth, inside paddles, 32 feet; tonnage, 820. They differed from their predecessors by being well armed. At each end they carried a 6-ton traversing gun of 10 inches caliber and throwing an 84-pound shot—the most powerful gun then in the service: in addition, there were four 18-pounder carronades for use in various other positions. We may therefore fitly describe these vessels as the first real war steamers in the British Navy. Further, the *Phoenix* fully justified her claims to military rank by taking part in the bombardment of St. Jean D'Acre in 1839. She appears to have fired her guns with precision from easily-occupied vantage points, and was used by the Commander-in-Chief (Admiral Stopford) as temporary flag-ship, so as to better superintend the operations. The *Salamander* took part in the second Burmese War of 1851, while the *Rhadamanthus* gained some notoriety as the first steam vessel to make the voyage to the West Indies in May, 1832.

In constructive features the *Phoenix* has a special claim to our notice as being a product of the famous master shipwright, Sir Robert Seppings, who was surveyor of the navy from 1813 to 1832. A glance at the accompanying plan and sections of her hull, in the way of the machinery spaces, will reveal the fact that the shipwrights—the actual wood engineers of those days—did their work thoroughly. The transverse framing here forms a solid wall of closely fitting English oak timbers, varying in thickness from 20 inches at the floors to a molded depth of 6 inches at the top sides; these are secured by treenails and dowels, and further stiffened and bound together by inner and outer wood-skins, each 3 inches thick. Two special deck beams, 16 inches by 24 inches, strengthen the structure abreast of the paddles and shafting, while iron knees are introduced inside and outside in way of the sponsons. Under the engines and boilers are four continuous, longitudinal bearers 14 inches wide and about 3 feet 6 inches deep; these were usually made from hard-grained balks of African oak, and secured to the adjacent ship structure by stout copper bolts clenched at each end.



SECTION THROUGH ENGINE ROOM OF THE PHŒNIX.

The boilers and engines of all three ships were identical, and were constructed by Messrs. Maudslay Sons & Field, London, who were first favorites with the Admiralty for this class of work.

As is well known, the marine boiler did not develop so rapidly as other types, owing to official reluctance to increase pressures, and thereby provide fresh victims for "the Moloch of high-pressure steam."

Iron tank boilers, arranged in two separate units, are here shown. They were fitted with internal, rectangular flues, which gave some circulation to the heated gases before they reached the common uptake. Water spaces were formed at

the boiler sides and bottom, as well as inside the flue walls and bridges. Stop-cocks were provided for shutting off individual elements when necessary; this arrangement was quite an innovation, most ordinary vessels being without such valve or cock, and thus there was a free communication between the boilers and steam pipe. A contemporary writer upon the subject, however, is impressed with the necessity of all war steamers being provided with such fitting, owing to the difficulty of repairing a boiler if perforated by shot. Water, of course, was drawn directly from the sea, and therefore brine pipes and blowout cocks were necessary for getting rid of the saturated liquid and earthy matter. The need of an external supplementary valve for this and other purposes brought the introduction of the Kingston valve at this period by Mr. Kingston, of Woolwich Dockyard; it consisted of a simple rod and conical valve, worked by hand, and opening outwards; by closing it, any necessary repairs could be safely done to the internal cocks and fittings. They were not universally used at this time, some early steamers having to blow out through their seacocks, thus emptying their boilers, which had to be refilled before steam could again be raised, the vessel, meanwhile, being compelled to sail, drift, or anchor for at least two hours.

Steam pressures varied from 4 to 5 pounds per square inch. Safety valves, steam and water gages were generally fitted. Tubular boilers were adopted in the navy about 1840.

The propelling machinery, in general design, is representative of the side-lever principle in its most popular, practical form. Two independent sets of engines, double-acting and condensing, drove the paddle shaft by means of cranks at right-angles to each other; this gave an easier and more uniform motion, with less liability to absolute breakdown, than the single engine of the earliest boats. A striking feature of the whole design is the heavy character and architectural form of the upper and lower head-stock framing in cast iron—the Gothic style here shown being a favorite one. The two sway-beams or side-levers to each set were 14.25 feet between centers, and were driven by the metallic-packed piston (a rarity at this period) by means of side rods attached to a cylinder cross-head. Rectilinear motion was given to the piston rod by radius bars from each side rod acting through a rocking shaft on the main framing, and a single back link to one of the side-levers.

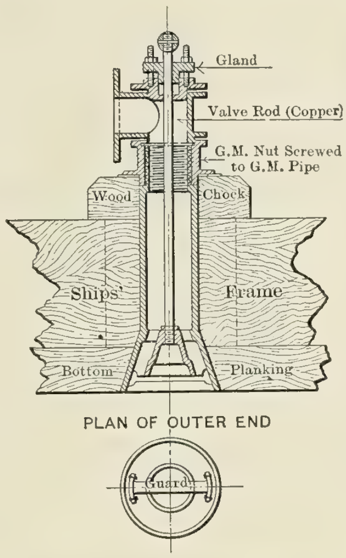
Long D slide valves were used, each actuated by an eccentric rod from the paddle shaft to an arm on the working-gear shaft. The condensers, each placed inside the lower framing, were of the jet type, and supplied by a sea-injection valve similar in character to a Kingston, but provided with a grid and guide rod; it was kept open by a cotter pin. Above the condenser was the "hot well," and above this again the peculiar dome-shaped "air cone," used to prevent any water escaping into the engine room. The condenser was cleared by a vertical single-acting air pump—a foot or clack valve regulating the operation; the pump was driven by side rods from both main levers. For convenience in disconnecting the cranks, when under sail, as well as to reduce the shock to the engines of heavy seas striking the paddles, the crank pins were made in two parts, connected by an intervening piece or driving link—a variation of the drag link: under normal circumstances the paddles could be thrown out of gear in about 5 minutes.

All working parts, except the main levers, were wrought iron. Each set of engines was 110 horsepower. The cylinders were 55.5 inches diameter, with stroke of 60 inches. The paddle-wheels were 20 feet diameter and had fixed floats 8.5 feet by 2.5 feet. With an average of fifteen strokes per minute, a speed of 8 knots was obtained. As far as authentic records of coal consumption exist, they point to 7 to 8 pounds per indicated horsepower.

A scale model of an almost identical set of engines—for H. M. S. *Dee*, 1827—is shown in the machinery section of the Victoria and Albert Museum, South Kensington: it is supposed to have been made by Henry Maudslay himself.

The estimated weight of this type of marine equipment, including engine, boiler and water, and paddles, was 1 ton per horsepower. With the somewhat later direct-acting engines and tubular boilers, this was reduced to 12 hundredweight per horsepower.

Notwithstanding its weight and space occupied, the side-lever engine had the advantages of giving an easy, effective motion to the piston, owing to the great length of connecting rod; the weight of moving parts were so balanced that the piston was in equilibrium and easy to start, and there was less wear and friction in bearings than in most rival types of marine engines. In the mercantile navy this type found even greater favor than in the Royal Navy: all the early Cunard liners were fitted with them—the finest and largest example, perhaps, being those of the famous *Scotia* (1861), the last paddle-driven Cunarder; they had cylinders 100 inches diameter driving, with a 12-foot stroke, paddle-wheels 40 feet in diameter.



DETAILS OF THE KINGSTON VALVE.

Paddle-driven warships probably reached their highest development in 1845, by the construction of the *Terrible*—one of the most powerful vessels of her time. She measured 1,847 tons, had four (direct-acting) cylinders of 72 inches diameter, developing 800 horsepower, and carried sixteen heavy guns.

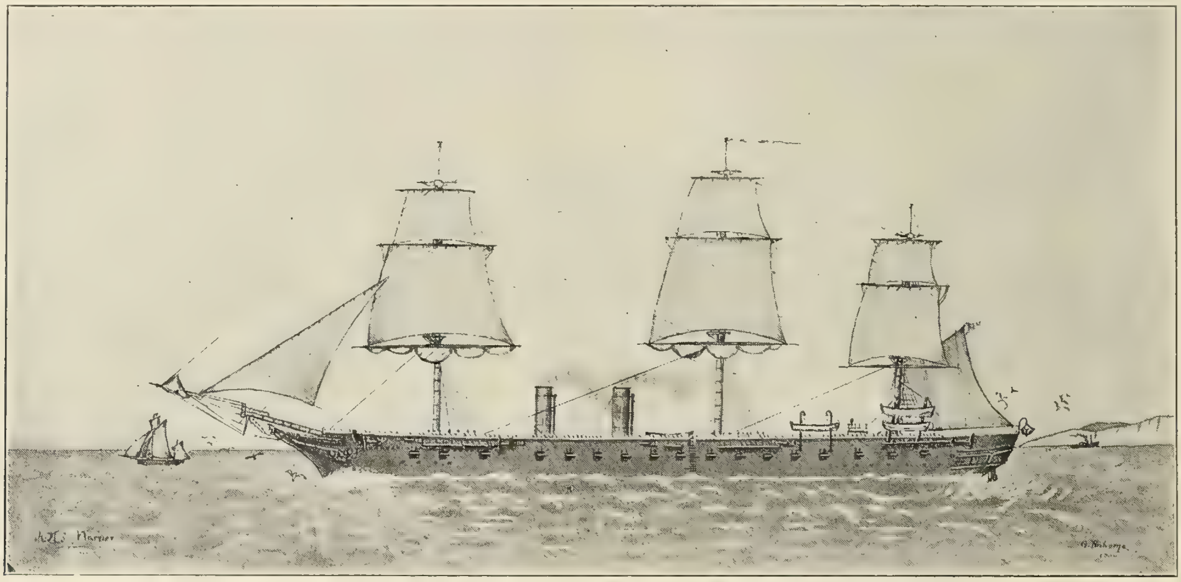
In these swaddling days of steam, sails were a necessary auxiliary in all vessels, but it is an interesting fact that it took the Royal Navy just a half-century to grow out of them. As far as possible, in the *Phoenix*, the rig was simplified, and the upper masts and yards were easily lowered on deck when steaming.

Of course, the paddle steamer *per se* was never the *beau ideal* of a fighting machine, and from this date it was rapidly displaced by the screw-propelled ship. Apart from its intrinsic merits, this change made a strong appeal to what one may describe as naval æstheticism. If steam had to be tolerated, how much more ship-shape to place its externals out of sight than to have two ungainly excrescences amidships? That the underwater propeller was less vulnerable was, perhaps, of no greater importance than that it avoided broken sheer lines and permitted once again the long serried rows of gun ports; aye, and even adapted itself readily to the picturesque three-deckers of the "good old times." In 1842, therefore, we find the *Phoenix* transformed: fitted with a 12-foot screw propeller and Penn's vertical, oscillating engines, with which she realized a speed of 8.7 knots.

G. P.

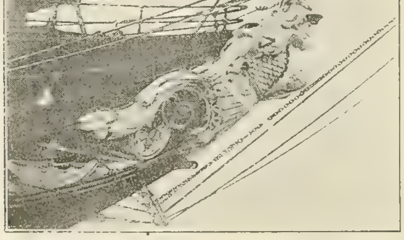
THE FIRST SEA-GOING ARMORCLADS.
La Gloire of France; the Warrior of Great Britain.

This year marks the jubilee of armorclad ships-of-the-line. That the present type of battleship, with its complex machinery and marvelous capabilities, should have had its inception and development easily within the memory of living men seems scarcely credible. So familiar have become the outlines and attributes of the modern naval fighting machine that one rarely realizes that at the beginning of the Crimean War, in 1854, the combined fleets of Great Britain and France before Sebastopol were entirely wood-built *unarmored* vessels, and many of them guiltless of the means of paddle or screw propulsion. Indeed, so comparatively recent has been this constructive revolution that one of the original parents of iron-clad navies—the *Warrior*—is still in existence and doing good and singularly appropriate service in the British Navy as mothership to torpedo craft.



H. M. S. WARRIOR, THE FIRST IRON-BUILT SEAGOING ARMORCLAD IN THE WORLD.

Incidentally this raises the interesting question of the origin or parentage of the modern battleship. If this were ever the subject of academic discussion, it would be fairly safe to claim it as of Anglo-American extraction, with French god-parents. The bases of such a claim may be thus briefly stated: Stripped of its multifarious, not to say unnecessary, fittings, the first class battleship of to-day reveals an armored sea-going vessel built of steel, and carrying its main armament on movable turntables. These essential factors in the new naval *materiel* all came permanently into being during the momentous period of 1858-62. The practicability of the turret or revolving gun-platform was demonstrated with dramatic completeness by the American *Monitor,* and the suitability of the metal hull for all naval and military purposes by the British *Warrior,* the French having, meanwhile, solved the question of the sea-worthiness of armorplated vessels by their ocean-going, wood-built ironclads. The story of the phenomenal design, construction and success of the *Monitor* is well known, and it is therefore rather with the earliest developments of the modern warship in France and Great Britain that we propose to deal.

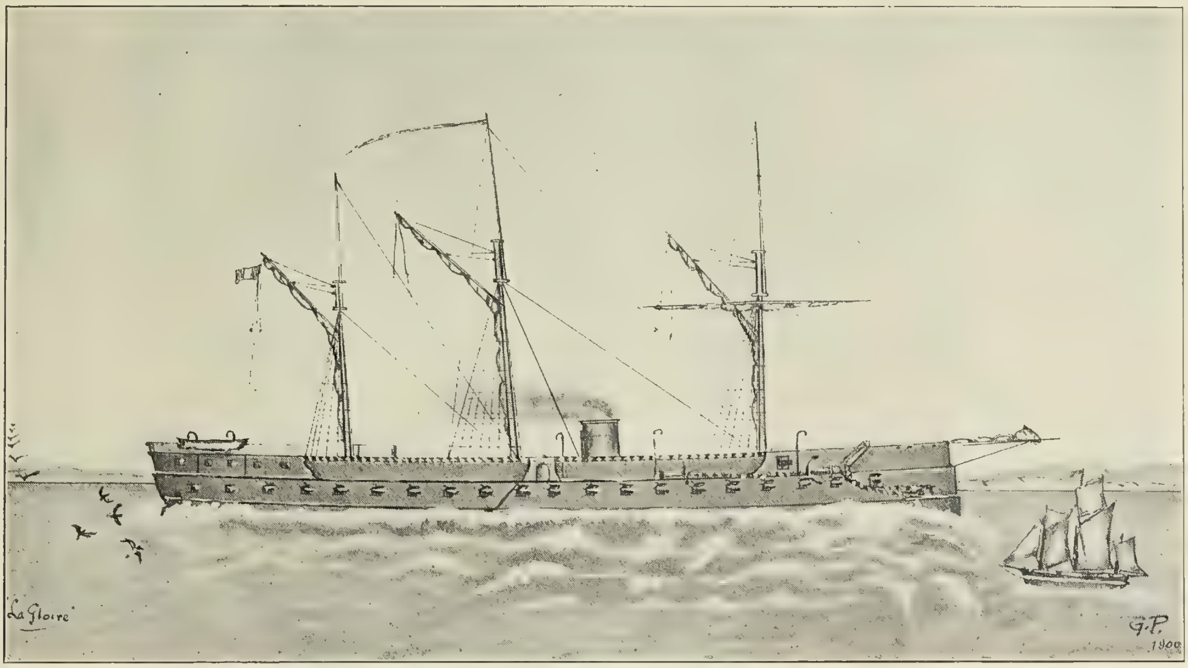


FIGUREHEAD OF H. M. S. WARRIOR.

To obtain a clear conception of the need for any such revolutionary changes in warship design, we must revert to the period when the explosive shell made its début as a destructive agent in naval warfare. At Sinope, in 1853, a Turkish squadron of twelve ships was attacked by shell fire from an inferior Russian fleet; and *a single Turkish ship alone* escaped to tell the tragic tale of conflagration and destruction. This gave food for thought to all the important Powers. Were not their magnificent fleets of wooden line-of-battleships and frigates all liable to the same fate? Such vessels could be relied upon to stand severe battering with orthodox missiles, as many a long, hard-fought engagement would bear witness; but against these bursting fireballs—scattering death among the gunners and blasting and burning with their fierce breath the stoutest oak timbers—they could hope to offer no prolonged resistance. Obviously, something was necessary to give the hitherto invincible wooden walls adequate protection against this new-found form of attack. All felt that a change in the existing order of things was impending—was imperative—but few dared to hasten the inevitable.

Undoubtedly the earliest attempt to put into practical form the current speculative theories upon this vital question was made by Napoleon III. In 1855 he built several small barge-like vessels, clothed them with thick iron plates and sent them into the forefront of battle against the Russian forts at Kinburn. To the surprise of an onlooking world they survived the fiery ordeal comparatively unscathed; both shot and shell fell harmlessly upon their protected sides.

So convinced was the British Government of the value of this experiment that they rapidly built a number of similar small batteries. But the ultimate logic of these significant events had yet to be reached. Light draft batteries, with small crews, little stability, and no maneuvering qualities could never form the first fighting line of a great sea power.



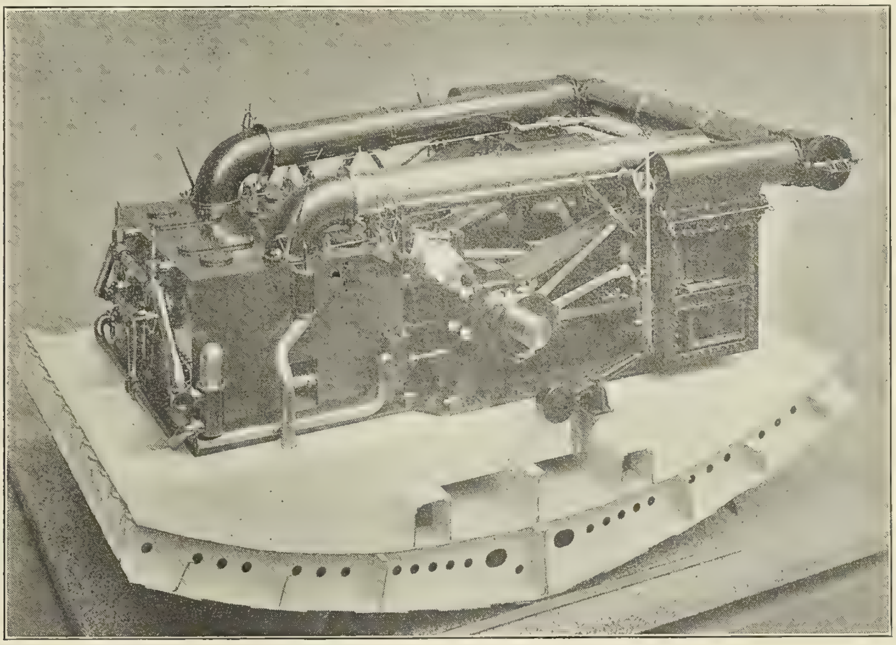
LA GLOIRE, THE FIRST FRENCH SEAGOING ARMORCLAD.

What then? Why—if mobility, sea-worthiness, coal-carrying capacity, fast-steaming qualities were as necessary as the powers of defense and offense—then the warship of the future must be a large sea-going ironclad!

It required little imagination to arrive at this conclusion, but it meant no small effort to the proud possessors of large, splendidly-equipped wooden fleets to fully realize its suggestiveness. Like a troublous nightmare, the problem of naval efficiency sat heavily upon the Great Powers.

Again the initiative came from across the Channel. M. Dupuy de Lôme, the eminent French naval architect and engineer, suggested the transformation of existing two and three-decked ships into single-decked armor clads by the simple expedient of omitting in the new design the heavy upper decks and substituting on the dwarfed and lightened hull a breastwork of thick plates.

On these lines, therefore, was constructed at Toulon in 1858-'59, the famous *La Gloire,* the first sea-going ironclad. As many existing accounts of the genesis of this noteworthy vessel are either vague or misleading, it will be well to give some authentic details on this matter.

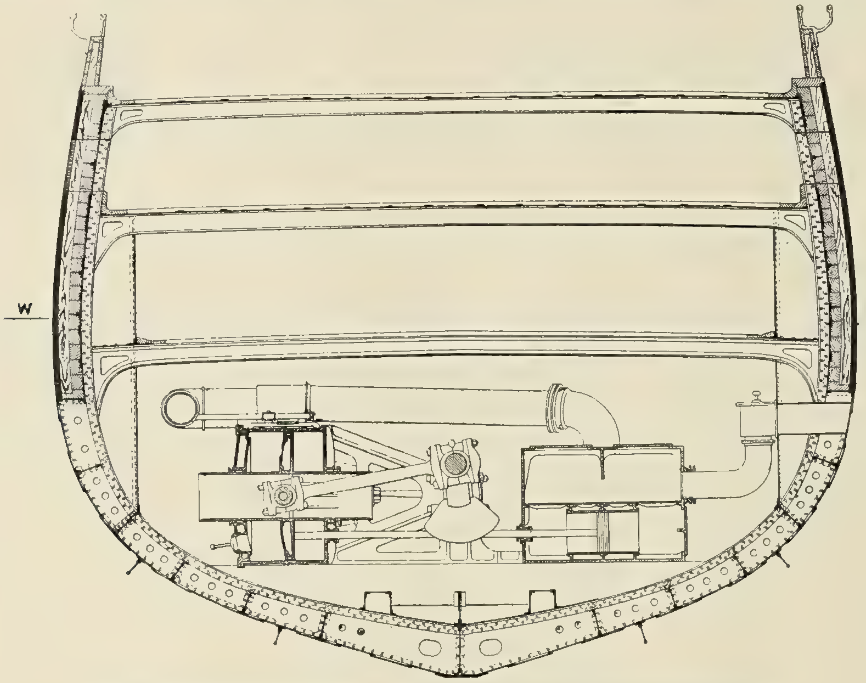


TYPE OF ENGINE USED IN H. M. S. WARRIOR.

To make one essential feature clear, *La Gloire* was an entirely new ship, and not a converted three-decker. M. de Lôme, with ten years' experience at the French Bureau of Construction, set about his task of heading a naval revolution with admirable caution, and with the least possible disturbance of existing traditions.

One of the most successful types of screw war vessel in the

French Navy at this time was a 91-gun class, known as the *Napoleon* or *Algèsiras* class, built in 1850-'55. Tested under steam and sail in all conditions of service, they had proved highly satisfactory. Assuming this safe type, therefore, as his criterion, and furnished with all necessary data as to their performances at sea, M. de Lôme carefully made—on paper—the calculated readjustments of weights to produce a new armored design, with all the established virtues of the old unarmored one. He found that by the removal of the two upper decks and their guns, plus a proportionate reduction in crew and stores that would naturally follow, he could save about 800 tons, or, approximately, the total weight of armor required for the protection of a frigate or one-decked design having the same displacement as the model ship. From plans prepared on these assumptions *La Gloire* was actually built.

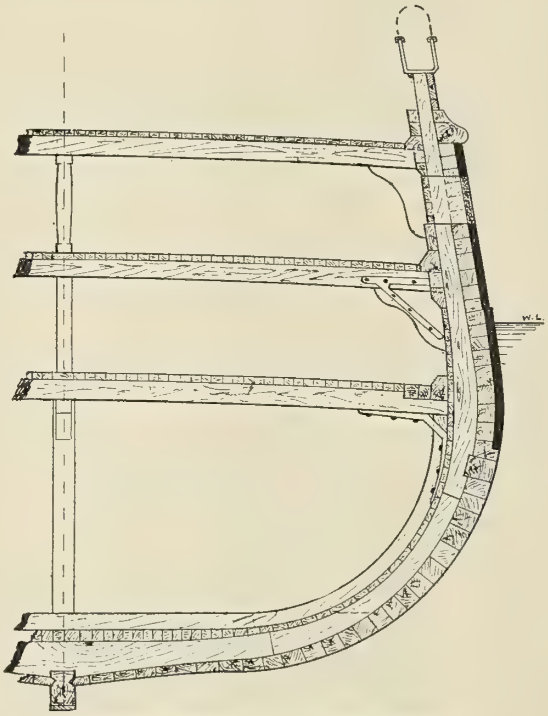


MIDSHIP SECTION OF THE WARRIOR CLASS, SHOWING LOCATION OF THE ENGINES.

As the normal hull-framing of the later types of wooden men-of-war was specially arranged to support heavy top-side weights, in the form of several tiers of heavy-gunned decks, it was fairly well fitted to carry this freshly-disposed load of external armor without undue structural straining. Few additions were therefore made in the new design to the massive bridge-like combination of vertical, horizontal and diagonal oak timbers with overlying riders, which formed the lower middle structure of the pattern type.

The upper works were built into a solid wall of timber in order to make a stout "backing" for the iron plates. A simple upright stem was substituted for the familiar overhanging cut-water, and some modification was made in the shape of stern to avoid extreme curvature in fitting the plates; these, with a slight addition to the total length of vessel, were the chief structural changes embodied in the new ship.

The cuirass, or belt of armor, extended completely around the hull, with a total width of 18 feet, of which 6 feet were below the waterline. It varied in thickness from 4 inches to 4.75 inches, sufficient to meet the attack of the British 68-pounder gun, the most powerful gun then afloat, and to thus give protection to thirty-four of her own main armament of 46-54-pounder guns. (It is a striking commentary on the half-century's progress in naval artillery to note that the modern 12-inch gun, or 850-pounder, is capable of penetrating 50 inches of wrought iron armor.) This armor plating consisted of *hammered* iron, in pieces 6 to 12 feet long and 2 to 3 feet wide, arranged brick-fashion on the side; the idea of *rolled* plates came from England at a somewhat later date. Each plate was secured in position by twenty to thirty galvanized wood-threaded bolts or screws 18 inches long and 1.5 inches diameter, with countersunk heads; these were considered preferable to nut and screw bolts under the jarring effects of shot attack.



MIDSHIP SECTION OF LA GLOIRE (1858).

A special feature of the upper deck of the new ship was an armored redoubt or conning tower. This formed part of the navigating bridge at the after end, and gave protection to the steering wheels, and to the responsible officers during action.

Following the usual practice in warships of this period, the

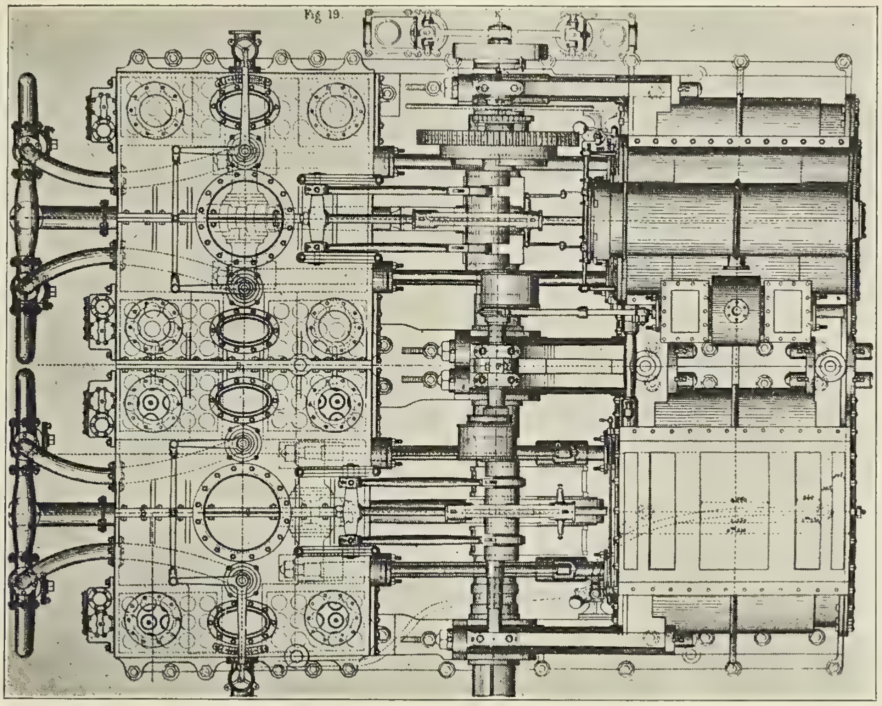
propelling engines were placed as low as possible in the ship's hold, as a safeguard from gun fire, and were arranged with remarkable compactness in the cramped spaces on each side of the propelling shaft. (It was not until nearly twenty years afterwards, when the armored or turtle-back deck at the region of the waterline gave special protection to the ship's vitals that the present vertical types of engines came into favor.) To meet the current requirements of height and space, therefore, the cylinders of all engines were horizontal, and either the "crank" or "return connecting rod" principle adopted to obtain the necessary length of stroke. It is interesting to compare three typical methods used by representative engineers to meet these demands. It will be seen by the *Warrior's* engines, Messrs. Penn made a passage for the piston and connecting rod actually inside the circumference of the steam cylinder. Messrs. Napier found a cooler place for the purpose, inside air pumps of large diameter; while M. de Lôme favored a recess or tunnel, formed inside the condenser area. These latter engines were of the return connecting-rod type that the designer had already popularized in the French Navy, and which eventually superseded all other forms; with slight modifications they continued in general use as late as 1885.

The two steam-jacketed horizontal cylinders were placed on the starboard side of the main shafting, while the condensers, of the jet type, were arranged on the port side. Solid, transverse timber-bearers, varying from 12 to 24 inches in thickness, formed a continuous engine bed some 20 feet in length. Each cylinder had a diameter of 81 inches and a stroke of 49.5 inches, the two cranks being set at right angles: on the underside of the cylinders were relief valves which automatically discharged accumulated water into the condensers at each stroke of the pistons—a precaution not then adopted by British engineers. Two piston rods were fitted to each cylinder, joined by a diagonal cross-head, working in top and bottom slides within the condenser recess. Distribution of steam was effected by long D-valves placed on top of the cylinders and operated by a valve crankshaft; this was arranged directly over the main shaft, from which it was driven by two equal spur wheels: motion was given to each valve by twin connecting rods from the valve shaft joined to a valve rod crosshead, which was carried in slides fixed to the top of the condensers.

Steam was supplied at 25 pounds per square inch by eight return flue boilers, arranged in sets of four on each side of the center line; there were four furnaces to each boiler.

A four-bladed propeller, 17 feet in diameter, was used: on trial with fifty-one revolutions per minute and 2,537 indicated horsepower a speed of 13 knots was attained.

At sea, the behavior of the experimental ironclad quite fulfilled the expectations of her designer; in speed, handiness and weatherly qualities she was at least the equal of her unarmored consorts. A fleet of similar vessels was at once projected and built, and it is a curious historical fact that, notwithstanding the rapid adoption of iron-built and armored warships by most other nations after 1860, the French retained confidence in their wood-built ironclads until 1872, when about thirty of such vessels had been added to their fleet.



PLAN VIEW OF THE ENGINES OF LA GLOIRE (1858).

Meanwhile, before the trials of *La Gloire* had demonstrated the practical success of so powerful a battle unit, Great Britain took alarm at the significant naval policy of her hereditary rival. As far back as 1855, English designers had submitted plans for new armored vessels, but divided counsels at the Admiralty had militated against their adoption. However, this formidable menace to British sovereignty of the seas was a trumpet-call to arms—an appeal for immediate and united action. From the dusty archives of Whitehall, from the secret lockers of the great engineering and shipbuilding firms, came a ready response. For a time, at least, the period of debate and vacillation had passed, and a unanimous cabinet sought and readily obtained the advice of practical men both outside as well as inside the government service. So prompt and so ungrudging were their labors that within a few months of the birth of the French prodigy a British rival was announced, larger—stronger—faster, and more revolutionary in character!

At Blackwall, in May, 1859, was laid down H. M. S. *Warrior*—the most novel, most powerful, speediest man-of-war of her time. Some idea of the boldness and magnitude of the step taken by the British Admiralty may be gathered from the following summary:

The *Warrior* was half as large again as her French contemporary, was a knot faster, and carried her battery of the heaviest guns afloat 3 feet higher than *La Gloire*. But far above these substantial claims to superiority was the unique fact that the *Warrior* was structurally built of iron! The massive wooden ribs and planking of *La Gloire* had been outmatched in strength, durability and lightness by a combination of metal plates and frames which, still further, possessed the inestimable virtue of incombustibility. Her graceful sheer, clipper-bow and general yacht-like lines were the admiration of even her critics, and were a striking contrast to the heavy, ungainly aspect of *La Gloire*.

But this triumph of British enterprise and skill was not originated or consummated without some opposition and difficulty. Serious obstacles were forever confronting the Parliamentary advocate, as well as the technical adviser. It required as much finesse and tact to pilot each untried revolutionary proposal through a House of widely divergent opinions as indeed it required engineering courage and resource to rapidly construct an unprecedented design in an entirely new material. The ultimate issue, therefore, was as much due to the untiring zeal of the Admiralty chiefs—Sir John Pakington and Sir Baldwin Walker—as to the practical skill of the Chief Constructor (Isaac Watts) and his colleague John Scott Russell, of *Great Eastern* fame.

One can scarcely realize, except by close study of contemporary records, the strong widespread prejudice against the use of iron for war-vessels that existed at this period. Iron had been successfully adopted in the construction of merchant ships and transports for over twenty years previously, but the idea of adopting such an experimental basis in the building of our first line of defense was, to many, fraught with grave national risks.

All tradition and long precedent was against it! The staunch old wooden walls had, from the time of Queen Elizabeth, worthily upheld the prestige of Englishmen upon the sea, and—was it altogether wise to introduce an entirely strange and new fighting machine? Further, the existing navy had been the gradual, almost imperceptible, growth of centuries. Modifications had slowly crept in as regards size and form of various classes, but the general features of the ship of 1850 were practically the same as of those which defeated the Spanish Armada in 1588. Now, the well-tried oaken timbers were to be hastily displaced by a new material, which, furthermore, had not escaped unscathed from the ordeal of several practical tests under gun fire.

The launching and rapid fitting-out of *La Gloire,* however, influenced many waverers. New iron vessels were laid down, and plans for larger and more costly units approved. At the same time the work on the *Warrior* was pushed forward, and just before the close of 1860, the hull was ready to leave the slipway of the Thames Yard Shipbuilding Company, Ltd. (now Thames Ltd.), Blackwall; her phenomenal launching weight of 4,350 tons made this event of special interest to shipbuilders and engineers throughout the kingdom. But the interest awakened by the building of the *Warrior* was worldwide, and more notables were to be seen at Thames Yard and Victoria Docks than, perhaps, ever visited a private establishment before or since. Royalties, Ambassadors, Attachés came from all the Courts of Europe, and, as a result, the Thames Yard ultimately received orders for the construction of many of the earliest iron-built armor-clads possessed by Spain, Turkey, Russia, Germany, etc.

In August, 1861, the *Warrior* was handed over to the government to complete her sea-equipment and prepare for trials.

As may be seen by the cross-section of this remarkable vessel, her general structural features bear a close resemblance to those of the modern battleship. There is a combination of longitudinal and transverse girder frames, the former being continuous throughout the greater part of the vessel's length, and spaced as shown, while the latter are worked intercostally and spaced 44 inches apart. It will be noted that the transverse frames extend slightly above the longitudinal, and are tied together by double angle-bars, which take the inner curvature of the hull: this was a precautionary detail of the early iron worker, which was soon discontinued as an element of transverse strength. The simple "bracket" plate, as used at present, was first adopted in the *Bellerophon* of 1865. At the extremities of the *Warrior,* the transverse frames were spaced 22 inches apart and formed of stout angle-bars (and reverse bars). The shell plating varied from 1⅛ inches to ½ inch in thickness. The cellular double bottom was limited in breadth to the first longitudinals on each side, and in length, to the machinery spaces. Watertight bulkheads and decks subdivided the hull at all important positions. Stem and stern posts were heavy iron forgings.

Box girders, fitted both fore-and-aft and athwartship, carried the weight of the propelling engines. These were of the ingenious "trunk" type, popularized by Messrs. John Penn & Son, of Greenwich. Their general character and arrangement is shown by our illustrations. The two cylinders were each 112 inches diameter; the largest ever cast for marine purposes at this time. To obtain a length of stroke of 48 inches in strictly limited space, the piston rods and guides were abolished, and light, sliding trunks, carrying the inner ends of the connecting rods and passing completely through the cylinders, were substituted. Occasional leakage of glands, and losses, due to the alternate heating and cooling of the trunk surfaces, appear to have been the only drawbacks to this excellent type of engine, which continued to be fitted to large warships as late as 1876. Steam at 22 pounds per square inch was supplied by ten tubular boilers, each fitted with four furnaces. Under steam trials in 1861, with a 24-5 foot Griffiths' screw, a speed of 14.35 knots was obtained, the engines making about fifty revolutions per minute.

Unlike *La Gloire,* the *Warrior* was not armor-clad from end to end. Her 4.5-inch iron belt, with 18 inches of wood-backing, extended over only 213 feet of her amidship length, an efficient termination to these armored sides, however, being given by armor screens or bulkheads across the ship, which afforded protection from raking gun-fire. The unarmored ends of the vessel were safeguarded by cellular subdivision.

Another marked difference in the designs of the two vessels was the treatment of sail propulsion. The *Warrior* was fully ship-rigged, and under sail-power alone proved almost as fast as the "crack" wooden frigates in the British Navy. A lifting screw propeller and a telescopic funnel provided for sailing cruises. Under both steam and sail power the vessel attained a speed of over 17 knots, making her by far the fastest warship afloat. In *La Gloire,* sails were considered chiefly as an auxiliary, a light schooner rig being adopted. When using sail alone, a short length of main shafting was uncoupled, and the propeller revolved idly in the water.

It is interesting to note that with the *Warrior* class ended the picturesque practice of fitting elaborately-carved figureheads in the British Navy.

The more distinctive particulars of the rival vessels are given in the following comparative table:

	La Gloire.	Warrior.
Length (waterline)	255 feet.	380 feet.
Breadth	55.7 feet.	58 feet.
Draft, mean	25.5 feet.	26 feet.
Displacement	5,700 tons.	9,000 tons.
Armament (original)	46 (54 pounders).	40 (68 pounders).
Guns, above waterline	6 feet.	9 feet.
Armor	4.75 inches (complete).	4.5 inches (partial).
Indicated horsepower	2,500	5,600
Speed	13 knots.	14.35 knots.
Weight of machinery	830 tons.	920 tons.
Cost of machinery	£50,000 ($243,325)	£75,000 ($364,990)
Cost of hull	£145,000 ($705,643)	£300,000 ($1,459,950)

These also afford opportunities for some instructive parallels with warships of to-day. A good impression of the relative size and appearance of the two ships is given by our illustrations, drawn to the same scale.

On the grounds of economy and expediency the French had every reason to be satisfied with their policy: vessels of *La Gloire* type were better maneuvered and armored, and could be produced more cheaply and rapidly than those of the *Warrior* type: it was, in fact, an ideal *transition* policy, and an excellent method of using up old *material.* It, indeed, had many adherents in Great Britain. Although vessels similar to the *Warrior* continued to be built, a number of the old wooden line-of-battleships were converted into ironclads. But, perhaps, the most amazing chapter of this vacillating, if epoch-marking, period, was the action of the British Government in purchasing huge stores of timber and continuing to build wooden warships that were already marked down for the shipbreaker by their own policy of iron construction.

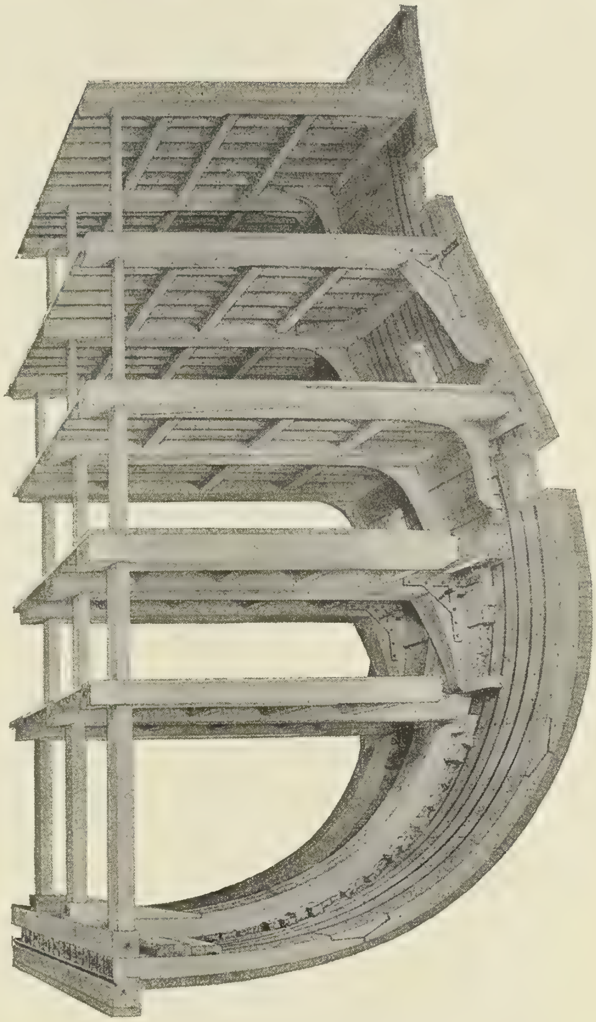
Of the reputed progenitors of the modern battleship then we have now only the *Warrior* left to us. Owing to recent alterations, it is too late to save the historic vessel in its entirety, but it is to be hoped that when the old craft has discharged her maternal duties unto decrepitude, something may be spared—something of her machinery or hull found worthy of national preservation, so as to hand down to posterity; some living, lasting memorial of a red-letter period in marine construction and engineering. P.

NELSON'S FLAGSHIP VICTORY.

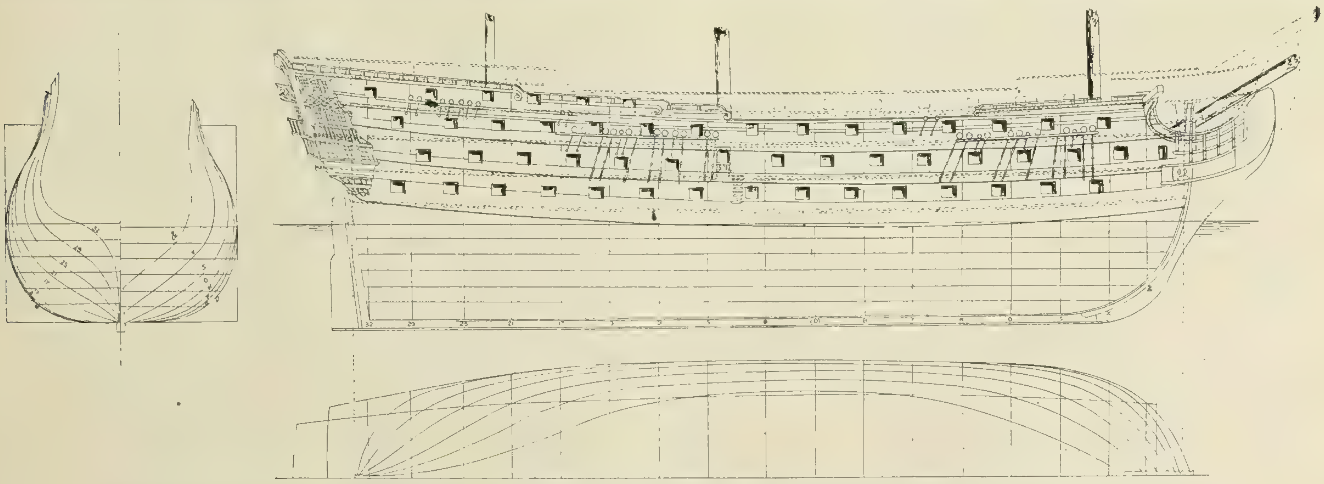
BY G. PINHORNE, M. I. N. A.

Exactly 150 years ago, in the Royal Dockyard at Chatham, was laid down the keel of the famous *Victory,* Nelson's flagship at Trafalgar. This eighteenth century relic, many times restored, but with much of the original oak timber work preserved within her, still floats near the entrance of Portsmouth harbor, where she has done duty as flagship for successive commanders-in-chief for over eighty years.

Interest in the great national hero and the old vessel, with which his name is imperishably associated, has been much stimulated in recent years by the work of the Navy League, as well as by the historical studies of Capt. (now Admiral) Mahon and other naval writers. In connection with this revival, one of the most novel and appropriate methods adopted to perpetuate the structural form, if not the name, of the vessel, was to have a steel-built ship as naval training school for poor lads, on the actual lines of the *Victory.* This idea was successfully carried out and the modern-built *Victory* took the name and place of an old wooden-built line-of-battleship *Exmouth,* which had been doing similar appropriate duties on the Thames for many years. Professor Biles, of Glasgow University, proposed the designs for the new *Exmouth,* and, at his initiative, a thorough search was made among the Admiralty archives, which resulted in the discovery of the original sheer draft of the *Victory.* This valuable but much dilapidated document has since been carefully copied, and a reproduction of it is given herewith. It was used in conjunction with the specially prepared sectional view, also shown, to illustrate a paper read by Sir Philip



PERSPECTIVE SECTIONAL DRAWING OF H. M. S. VICTORY.



OUTBOARD PROFILE, BODY AND HALF-BREADTH PLANS OF H. M. S. VICTORY. THE DOTTED LINES SHOW THE RECONSTRUCTED VICTORY.

Watts, director of naval construction, before the Institute of Naval Architects in 1905, the Trafalgar centenary year.

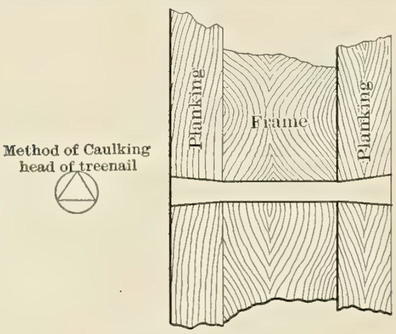
Here, then, we possess the key to an inner history of this remarkable ship, apart from, and corollary to, her oft-told achievements in 1805. To the ever-widening school of historical students and mechanics there is much of interest, something even of romance maybe, to be found in a short study of this unique product of long-past men and methods.

Upon the original sheer draft may still be traced the signature of Sir T. Slade, surveyor of the navy from 1755 to 1771, and dated "June 6, 1759." There is to be seen also a marginal note, "Named *Victory*, by order, November, 1765." This would seem to suggest that the new ship did not officially receive her name until the year of her launch. She appears to have been built to replace another *Victory*, which was lost off Alderney in 1744, with Admiral Balchen and 1,000 men.

From July, 1759, when the keel was laid, to May, 1765, when launching took place, the hull of the new ship was being slowly and laboriously pieced together on the slipway, the timbers, meanwhile, getting a certain amount of necessary seasoning. With the sectional view and supplementary detailed sketches before us, we may roughly estimate the work done and the manner of its doing.

First, the heavy pieces of the main keel, about 20 inches deep and 16 inches broad, were laid straight and true upon the blocks; they were of tough English elm, scarfed together in as long lengths as procurable. Then came the floors or lower parts of the frames, laid crosswise, and of similar sectional dimensions to the keel and tapering towards their outer ends. For the purpose of "breaking joint," these were placed with a long and a short arm, alternately on one side the keel. Upon this assemblage, and firmly secured to it by 1½-inch bolts, came the keelson, about 14 inches square, thus forming the backbone of the structure, which then gradually grew in breadth and length.

Magnificent as were the oak forests of this generation, no trees were of sufficient size to make a complete rib or frame of such a ship. Each frame was, therefore, built up of five or six separate pieces or futtocks, each futtock being of smaller section than that below it. These outreaching arms were temporarily held in place by means of horizontal ribbands and vertical props or shores. Where their whole curvature and positions correctly corresponded with the lines of the ship's body taken from the mold-loft floor, the angle chocks were fitted at their joints and doweled together, as shown by the sketches. All the midship frames were erected

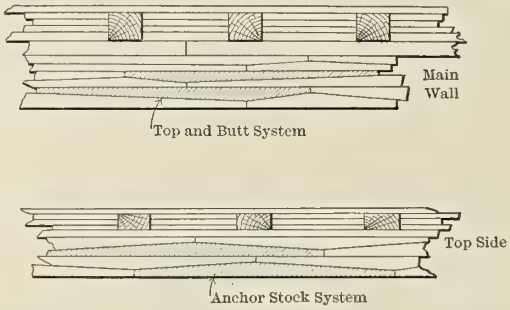


TREENAIL FASTENING.

squarely to the keel line; those at the tapering sections of the bow and stern were set obliquely or horizontally as circumstances demanded. Meanwhile, strakes of the external and internal planking were being worked upon the frames and secured by treenails "of dry, seasoned, English oak of the growth of Sussex," as the specifications set forth. We have illustrated this form of fastening, and it will be readily seen that a tightly driven treenail, well calked at each end, had considerable holding power and could not be taken out, except by boring with an auger. It was also not so liable to "work" as an iron or other metal fastening.

It will be noted that the outer planking varied in thickness. At the waterline the main wales were about 8 inches thick; these, with the thickness of frame and inner skin added, gave a protection of about 2 feet of solid oak at this vital region. The planking at the topsides was reduced to about 4.5 inches.

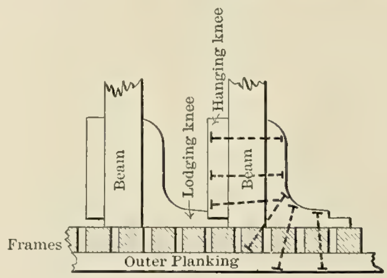
Our detailed sketches of portions of the ship's side show methods largely adopted for working the thicker strakes of



SIDE PLANKING, SHOWING METHOD OF USING TIMBER ECONOMICALLY.

plank so as to economize material. By sawing out the slabs into the "anchor stock" or the "top and butt" form the wider portions of the tree trunk could be better utilized than by cutting the planks with exactly parallel sides. Suitable timber was always difficult to obtain, and many ingenious expedients were adopted to obviate waste at the sawmills, or to use up odd pieces. The timber converter was an important appointment in the dockyard staff, and he became an expert in detecting faulty material and in adapting the natural curvature of any balk to its best service.

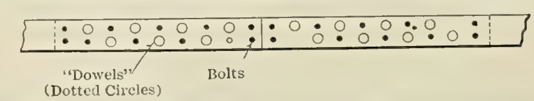
On the inside of the ship at the level of the various decks a number of extra thick planks were worked, known as clamps, and upon these rested the heavy deck beams, some 12 inches deep and 14 inches wide at the lower deck. By means of hanging knees fitted vertically underneath and by lodging



PLAN OF BEAM-END CONNECTIONS.

knees fitted horizontally at the sides, these huge timbers were efficiently connected with the sides of the vessel and offered considerable resistance to alteration of transverse form, as well as supporting the heavy tier of guns on the deck above. These beams were rarely obtainable in one piece, and the usual method of scarfing beams at this period is well shown in the sectional view.

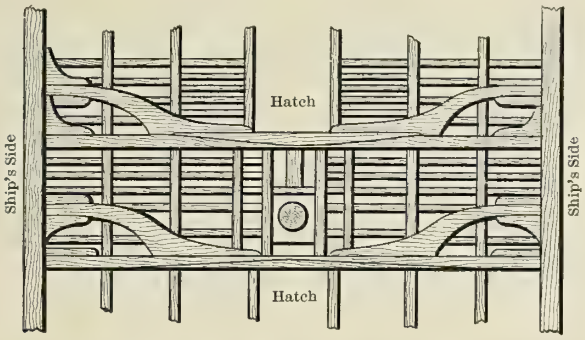
A detailed sketch explains the system of fastening the scarfs by means of dowels and bolts. The dowel or cylindrical plug was about 3 or 4 inches long, and was commonly let in half



METHOD OF SCARFING A BEAM, SHOWING DOWEL AND BOLT FASTENING.

way on the faying surfaces of any jointed parts liable to work or slide under severe stresses.

If possible, a deck beam was placed under each gun position; where, however, the masts or hatchways interfered with the fitting of whole beams, a short, crooked half beam was used to take the weight of gun, as shown by the plan of the deck



DECK PLAN IN WAY OF MAIN MAST, SHOWING ORDINARY AND CROOKED BEAMS FOR SUPPORTING DECK IN WAY OF HATCHES.

framing in way of the *Victory's* mainmast. When grown timber of sufficient size could not be obtained for the beam knee pieces, a straight-grained piece or chock was used, with iron side plates to join the beam, chock and ship's side together. The spaces between the main beams were filled up by lighter intermediate framing, about 5 inches by 4½ inches. This gave a foundation to take the fastenings of the deck planks.

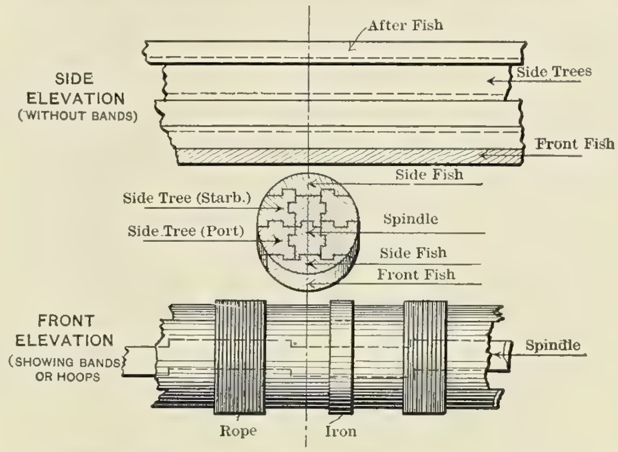
To fasten the deck, both treenails and dumps, a kind of large nail, were used; the heads of the latter were punched well below the surfaces and neatly covered by small diamond-shaped plugs, many of which may still be seen on the vessel. The decks were supported at the middle line by a series of stanchions or wood pillars, placed usually under each main beam at each deck and diminishing in diameter from the lower tier, stepped into the keelson, to the upper tier under the upper deck.

Huge pieces of grown timber of more or less angular form, arranged either horizontally or vertically, held together the sides of the vessel at the narrowed extremities and connected the stem and stern posts with the keelson. To satisfactorily connect one of these portions, known as the deadwood, through bolts some 14 feet in length were necessary. These bolts were clenched at each end and were of iron; copper bolts came into use for this purpose about 1783.

As soon as all the inner planking was in place, the heavy double riders were worked at intervals right across the hull from the height of the lower or orlop decks on each side. The head of one of these riders appears in the view of the cockpit where Nelson spent his last moments, and which was situated on the after end of the orlop deck. These stiffened the underwater body of the structure transversely, but, as the critical reader has perhaps already noted, there was little provision, beyond the inner and outer planking, to resist longitudinal bending. A tendency to hog or drop at the extremities, forming an arched or hollowed keel line, was a common fault with these vessels after several months' sea service. This was well known to the early builders, and handicapped them in any attempt to give their vessels increased dimensions. Increase of length meant assuredly increase of trouble in this direction, and perforce they added another deck to their stature to get any additional armament. The rocking stresses occasioned by carrying these heavy top weights were somewhat obviated by giving the sides of the ship considerable tumble-home, as shown by the sectional view. This allowed the upper guns to be placed nearer the center line of the ship. It was not until after Trafalgar, in 1810, that the hogging difficulty received successful treatment at the hands of Sir R. Seppings. His was simply a more scientific arrangement of materials. He omitted much of the inner bottom planking and a bridge-like combination of diagonal trusses and braces worked upon the frames throughout the greater length of the hold and treated the top sides, in way of the gun ports, in a similar manner. When one remembers that after a hard day's battle a great deal of these old ships' upper works were actually shot through or badly damaged, it is not surprising that such a structure, with her chief longitudinal ties cut away, should break and suddenly sink.

Sir R. Seppings also advocated the abolition of the bulkhead or thwartship partition at the forecastle. Being but a light wooden screen, it afforded but little protection from a raking fire, and the *Victory's* upper deck crew suffered severely on this account at Trafalgar. Instead, therefore, of ending the topsides of the vessel thus abruptly, he carried them in a natural curve to the stem piece and gave additional room with better appearance and protection. A comparison of the modern *Victory* with the original profile will make this alteration clear, as will also a reference to the special front view of the bulkhead. The doors here shown provided facilities for the men to work the head sails.

An excellent example of the piecing together of small timber, to make a thoroughly reliable combination, is afforded by the mast construction of these times. A portion of the



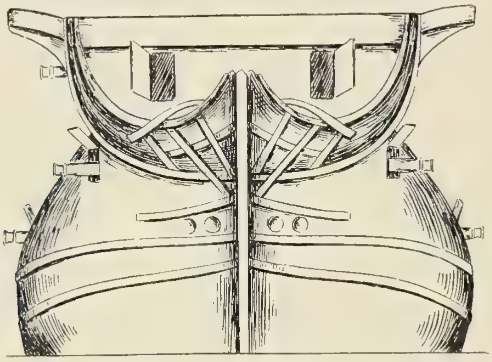
CONSTRUCTION OF LARGE MASTS, SECTION NEAR UPPER DECK.

mainmast, near the upper deck, of a vessel of the original *Victory* class is here shown. Its careful inspection reveals to us something of the nature of the proverbial Chinese puzzle. The *Victory's* original mainmast would have been about 200 feet in length, from waterline to truck, and about 39 inches greatest diameter. She was one of the fastest vessels of her class in the navy, with an average speed of 4 to 5 knots. The speediest frigates of the day probably reached 8 or 9 knots. At sacrifice of some sentiment we hasten to add that the masts at present fitted to the *Victory* in no way resemble those we have indicated. They are about 4 feet shorter than the originals and are made of iron. It may be explained that they really belonged to the British iron screw frigate *Shah,* which rendered herself famous by an engagement with the Peruvian monitor *Hussar,* in 1877.

At the battle of Trafalgar the armament of the *Victory* actually consisted of 104 guns, made up and distributed as follows:

Lower deck	30 long 32-pounders of 36 cwt.
Middle deck	30 24-pounders of 36 cwt.
Main deck	32 12-pounders.
Upper deck	8 short 12-pounders.
Upper deck	2 short 32-pounders.
Forecastle deck	2 short 68-pounders.

For many years it was believed that only four 24-pounders remained in the vessel of the original armament. In 1906, however, evidence was forthcoming which satisfactorily proved that there were also eight 32-pounders in the lower deck, which had equal claims to originality. These cannon were all of cast iron, and mounted on wooden carriages at 8 degrees elevation; the 24 or 32-pounders had an effective range of about 2,000 yards. In action, especially at close quarters, these guns were double or treble-shotted. Taking

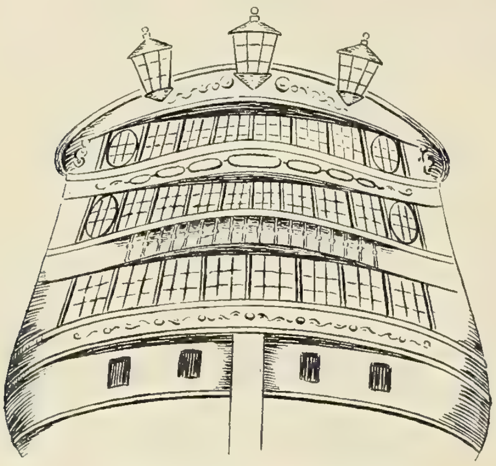


SKETCH OF BOW VIEW OF VICTORY.

an average of two to three shots per discharge, the *Victory's* weight of broadside fire, in modern terms, would be about 2,500 pounds.

What little machinery was used aboard these early craft was of a simple character, and human muscle was the universal motive force.

Grouped around the mainmast on the lower deck were the pumps for clearing the leaky bilges, a water course or channel being formed on either side of the keelson throughout the ship's length. Four chain pumps and one or two suction pumps were probably the original equipment, although supplementary modern fittings may now be seen. Each chain pump, about 7 inches in diameter, had a continuous sprocket



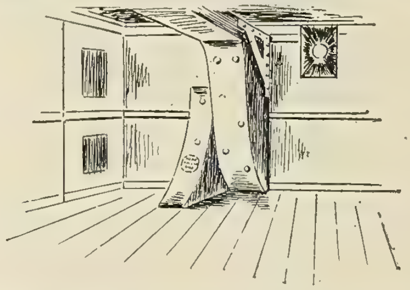
SKETCH OF STERN VIEW OF VICTORY.

chain, carrying closely-fitting disks or cups, working in trunks or barrels that reached down into the well formed around the heel of the mainmast. They were driven by long well-manned crank handles, were fairly efficient, and rarely got out of order. The simple suction pumps were worked by long, lever handles. A lead pipe or scupper conveyed the water overboard through the ship's side.

Two sets of large wooden capstans were provided, one set placed just abaft the foremast, and the other abaft the mainmast on the lower and middle decks. These were used for working the anchors, each about 2.5 tons in weight, and for any heavy lifting or haulage operations. They were revolved by twelve long ash-wood bars, fitted into a crown of nearly 6 feet diameter, and were usually made with upper and lower drums, so that they could be manned on either or both decks if desired. Simple drop-pawls on the lower rim of the capstan prevented return or reverse motion. The hemp cables used for heavy work were 8 inches in diameter. Sir Walter Raleigh (early seventeenth century) records the introduction of the chain pump and capstan for use on shipboard, and this affords us a typical instance of the unprogressive character of naval science during the two centuries ended by Trafalgar.

The steering gear consisted of a horizontal barrel, mounted in bearings upon two stout stanchions between the upper and quarter decks, and revolved by a hand wheel at each end. Hide ropes connected the barrel with the tiller-end below the main deck, and were so arranged through pulley blocks and fairleads as to give the least possible slackness of rope at any angle of tiller.

The pulley in the form of tackle, the wedge in the form of quoins under the breech, and the hand spike or lever were the elementary mechanical appliances used for training, elevating and otherwise manipulating the guns. Loading, ramming, cleaning, etc., were simple manual exercises, as was also the transport of powder and shot. Sighting was usually a question of deciding to which part of the rigging of the opposing



SKETCH OF COCKPIT SHOWING HEAD OF HEAVY DOUBLE RIDERS.

ship the gun should be directed, so that the shots should strike her hull. Tabulated notes were kept, giving the various parts of rigging to be aimed at when at different ranges. A lighted match, applied at the breech, discharged the gun.

For the working of yards and sails several forms of tackle were used as at present; the remarkable rapidity and precision with which the most involved operations were performed depended largely upon the possession of an active and well-disciplined crew.

Before commissioning, the vessel was coated with an anti-fouling mixture made of pitch, tar and sulphur, below the waterline. Copper sheathing for this purpose was used after 1780.

The principal dimensions of the *Victory* were as follows:

	Feet.	Inches.
Length on the gun decks................	186	..
Length of the keel for tonnage..........	151	3⅝
Beam, extreme..........................	51	10
Beam, molded...........................	50	6
Depth in hold..........................	21	6
Tonnage................................	2,162 22/94 tons.	

Having briefly described the ship and her equipment, we may turn for a few moments to the interesting records of her career.

Her early years appear to have been exceedingly prosaic, in striking contrast to a future filled with historic and brilliant achievement. After her launch in 1765, she remained in reserve for thirteen years, doing no active service. In 1778 she was commissioned as flagship to the Hon. A. Keppel, and took part in a successful attack on a French fleet off Ushant. Under Admiral Kempenfeldt, near the same place, in 1781, she assisted in capturing fifteen merchant ships and sinking their convoy of four French frigates. She was present, under Lord Hood,

at the capture of Toulon in 1793. At the battle of St. Vincent, in 1796, she captured the *Salvador del Mundi* of 112 guns. For about two years she was used as a hospital and prison ship for prisoners of war, and appeared likely to end her days as a hulk. However, in 1798 it was decided to modernize her, and the upper decks were entirely reconstructed. She was completed about 1803, and the dotted lines on the original sheer draft show the general effect of these alterations. On completion, Nelson chose her as his flagship, and in the same year she captured the *Ambuscade.* Two years afterward, with the same admiral, she formed part of the historical fleet of twenty-seven British ships that fought the great fight with thirty-three French and Spanish ships off Cape Trafalgar, capturing nineteen of the enemy's ships but losing their own immortal commander in the hour of his most stupendous success. The calculating student may have noted that the *Victory* was actually forty years old at this famous battle. "Too old at forty" may apply to *some* modern men and to all modern battleships, but not to the naval *material* of those days. In 1808 we find the *Victory* again a flagship in the Baltic, and then in 1812 she was commissioned for the last time. No less than six admirals applied for her as flagship in 1815, but the long war period having now ended she was not again fitted out.

In 1830 she underwent another extensive refit, and five years subsequently began her duties as flagship in Portsmouth harbor, which have continued to the present day. About twenty years ago she was thoroughly overhauled, replanked and refastened in Portsmouth yard.

In 1891 a proposal was made to take the old vessel round to the Thames and moor her off Greenwich, in connection with a great naval exhibition held at Chelsea. Although this idea was never carried out, the ordinary sightseer in London and provinces had an excellent opportunity of realizing both the internal and external appearance of the ship by means of a full-sized replica, from waterline to bulkwarks, built up in the grounds of the exhibition.

It will be recalled that just over a year ago the *Victory* had a narrow escape from destruction. Lying close to the fairway near the harbor entrance, she was accidentally rammed by the dismantled hull of the obsolete ironclad *Neptune* (1878), which was being towed away to the ship-breakers. Serious leakage was discovered, and it was officially discussed whether any repair was possible or advisable. However, largely owing to the timely intervention of His Majesty the King, the interesting old relic was saved and received a thorough repair.

Following this dramatic incident came an influential movement for the complete restoration of the *Victory* to her actual appearance at Trafalgar, or, at least, a removal of some of the most glaring anachronisms in external contour. It received sufficient consideration for rough estimates to be proposed for carrying out the work, but the matter has apparently been shelved. One step, however, has actually been taken to give some old-time verisimilitude to the present outlines. Three old-fashioned poop lanterns have been affixed to the stern, similarly arranged to those shown on our illustration of an eighteenth century ship. It is interesting to record that these lanterns, about 5 feet in height and painted yellow, were made by the naval artificer apprentices in their floating workshop at Portsmouth.

Although some differences of opinion exist as to the actual coloring of the famous vessel in 1805, it is highly probable that she was painted in Nelson's own black and white cheques, and retained the vermilion inboard works of contemporary usage. To substitute these colors for the present black and white cheques would be an inexpensive concession to archælogical reformers.

The *Victory* is undoubtedly the best existing example of an eighteenth century man-of-war. A few others still remain as hulks or depot ships in and about the Royal Dockyards, or as training ships around the coasts, but their numbers dwindle each year. Some recent specimens when broken up have evidenced a remarkable state of preservation. With, therefore, a tolerant, if not altogether sympathetic, Admiralty to undertake periodical survey and repair, coupled with the jealous watchfulness of the growing body of naval students, the old vessel should be spared for many generations to come as a typical example of early marine architecture.

THE GREAT EASTERN.

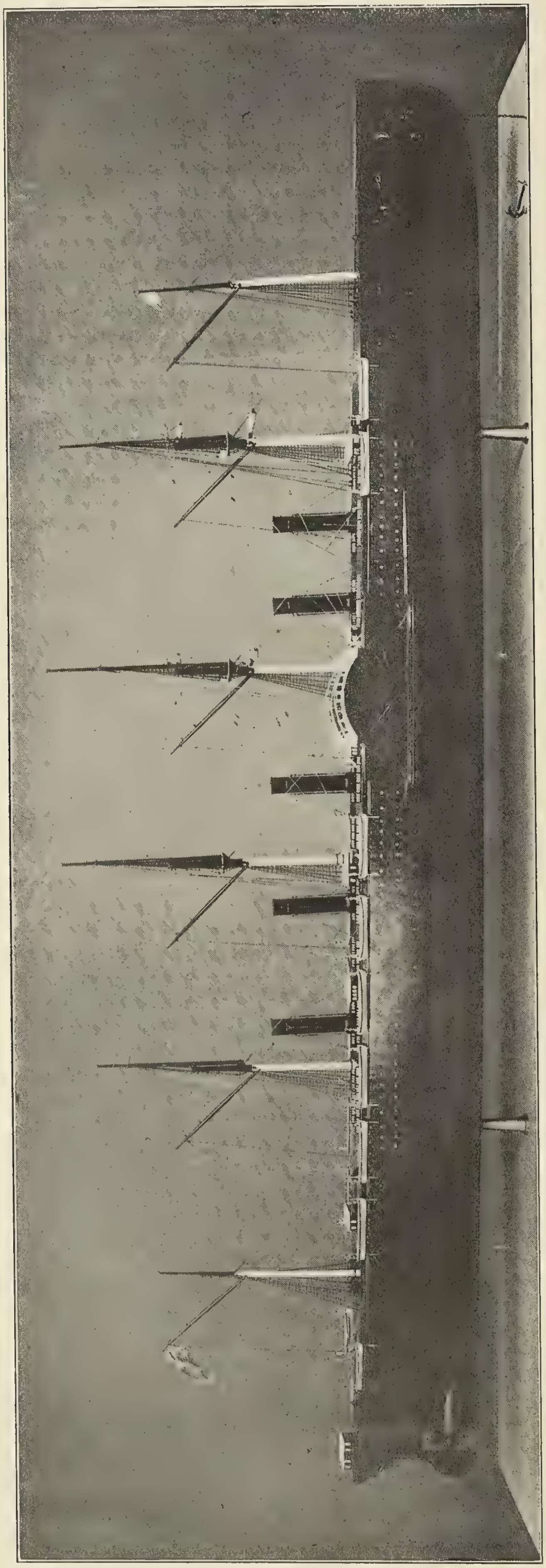
During the middle half of the nineteenth century the term "engineer" reached perhaps its widest latitude; it, at least, had few of the limitations at present set by modern specialization. Any mechanical problem with iron and steam as chief factors came readily within its significance. Wherever the ancient coach builder, or shipbuilder in particular, failed to annex the new ground opened up by mechanical traction or iron construction, the vacant territory was at once occupied by the colonizing engineer.

When, therefore, in 1852, I. K. Brunel, tunnel worker, bridge builder and architect, docks superintendent and railway engineer, suggested to the Eastern Navigation Company the possibility of building a steam vessel much larger than any then existing, and, by virtue of her increased dimensions, making much more lengthy voyages at higher speeds, no one was greatly surprised. Nor when the design and construction of such a ship were entrusted to John Scott Russell, formerly college professor and civil engineer, and finally head of a shipbuilding establishment at Millwall, on the Thames, was there any professional comment. The surprise came when the actual dimensions of the proposed vessel became known; then all the world, including the professions, marveled.

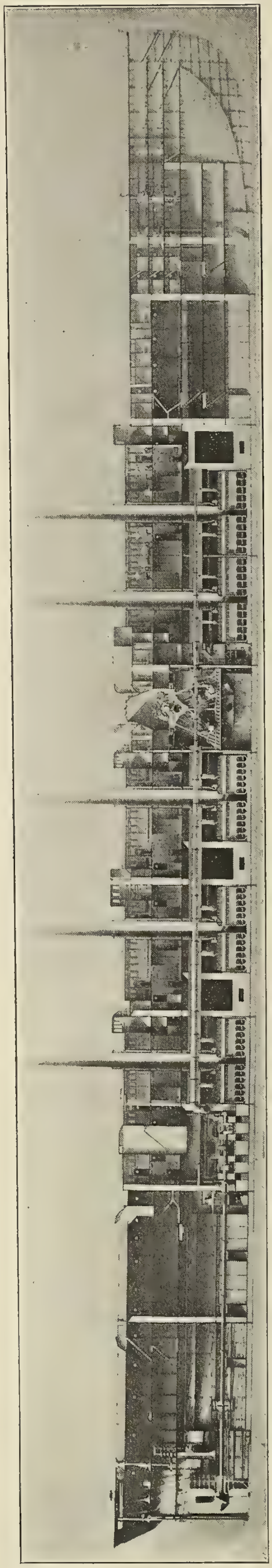
This "Leviathan," afterwards rechristened *Great Eastern,* was to have an over-all length of nearly 700 feet, or more than twice the length of the previous monster ship the *Great Britain,* which in turn was already 100 feet longer than any existing line-of-battle ship!

True it was that the daring projectors of this colossal floating structure had had some special experience calculated to fit them somewhat for a task of such magnitude. Brunel had assisted at the building of the *Great Western* of 1838, the largest and fastest wooden vessel of her time. Convinced of the economical value of big ships, but also of the impracticability of constructing them in wood, he had himself subsequently undertaken the task of building the aforesaid *Great Britain* (1839-1843), of unprecedented dimensions, in iron. His co-worker, Scott Russel, had been associated with a shipbuilding firm for some years, but his peculiar fitness for the entirely new problem now submitted to him was his intimate first-hand knowledge of ship forms and resistance. A life-long experimenter with small-scale models, he undoubtedly helped largely to foster a line of research which has resulted, in our own time, in the establishment of experimental tanks for similar purposes at all important naval centers. What Scott Russel did not know concerning the relation of under-water form to speed and other kindred basis theories in ship design few, in his day, were able to inform him. Still, even with such men as these behind it, the project was a stupendous one.

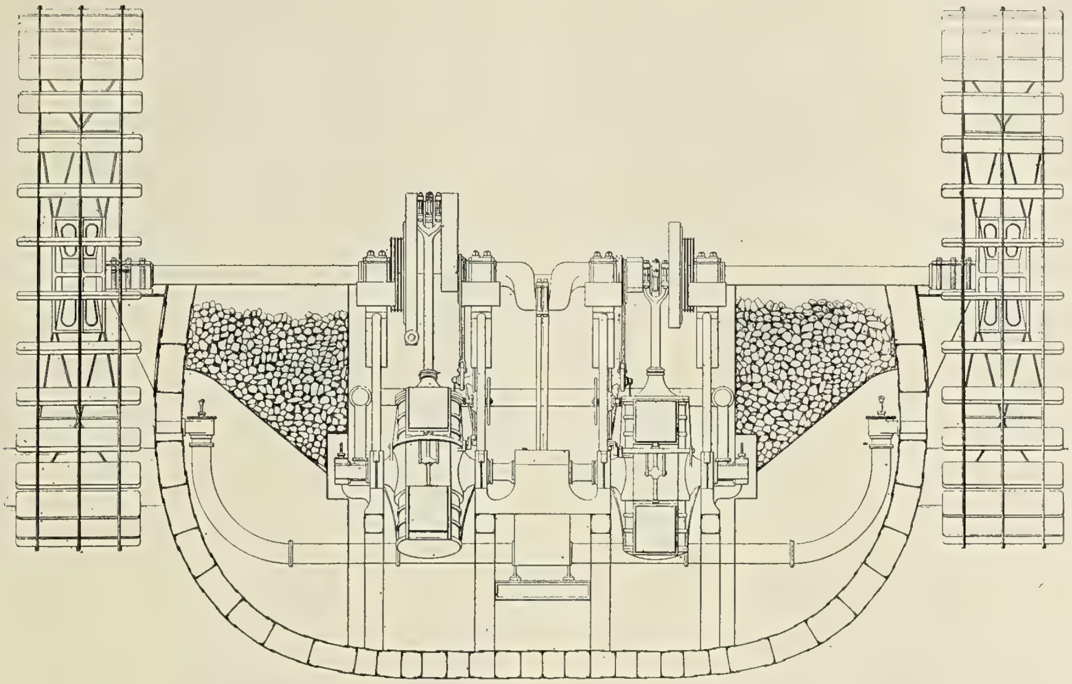
Encouraged by the success in small vessels of his famous "wave-theory" of ships' lines, Scott Russell at once embodied the principle in his design for the *Great Eastern.* The waterline length of 680 feet was divided into a parallel middle body of 120 feet, with an entrance of 330 feet and a run of 230 feet, formed on the new theory. This innovation in design was



MODEL OF THE GREAT EASTERN.



INBOARD PROFILE OF THE GREAT EASTERN.

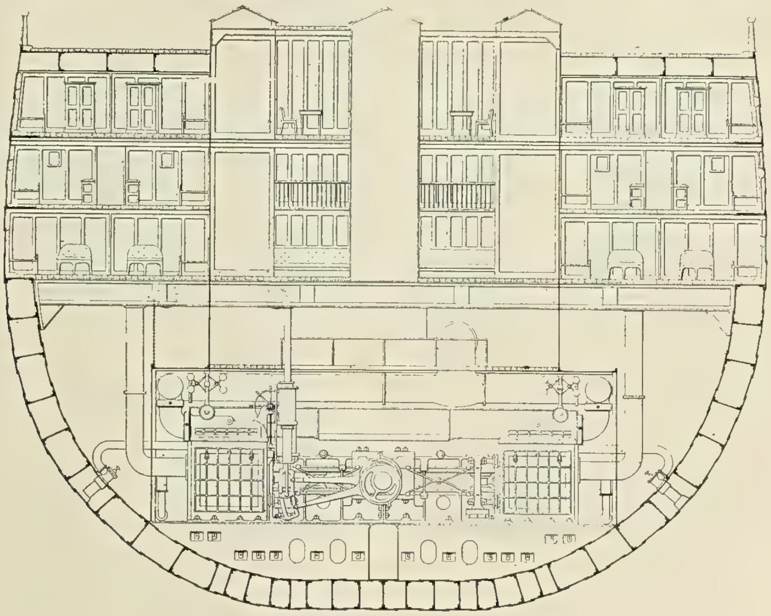


SECTION THROUGH PADDLE ENGINE ROOM OF THE GREAT EASTERN.

coupled with some still greater novelties in general construction.

First, the hull would be practically a floating bridge structure. Brunel's experience in connection with the building of the Britannia tubular bridge across the Menai Straits, and Scott Russell's actual experiments in the building of small ships, had taught both responsible architects the immense value of the longitudinally arranged girder in any structure, floating or otherwise supported, having great proportional length to breadth. Therefore, the closely-spaced transverse ribs, largely a tradition of the wood shipbuilders, were entirely abolished in the new ship, and the whole under-water portion of the hull formed of a number of continuous fore-and-aft girders or frames. When connected with an inner and outer skin of stout plating, and sub-divided by a number of widely-spaced 'thwartship plate frames, this made in itself an immense cellular girder of great strength and safety. The upper deck, or the top flange of this girder hull, was likewise of double or cellular formation. Further longitudinal assets of considerable value were two main bulkheads extending parallel, 36 feet apart, over the whole 'midship length of the vessel. The necessary transverse stiffness and internal sub-division were obtained by a number of cross bulkheads, intact below the second deck. These were so arranged as to provide five separate boiler rooms and two separate engine rooms, each 40 feet in length, as well as a number of cargo holds beyond the machinery space, each 40 to 60 feet in length. Partial bulkheads or frames gave supplementary strength and subdivision in way of coal bunkers, etc., and at the extreme ends of the ship an elaborate system of watertight compartments was followed out.

It is an interesting commentary on the so-called "longitudinal system," as here adopted in its entirety, that, though most modern ship constructors have largely adopted a compromise system, partly longitudinal and partly transverse, yet there has always been a distinct tendency towards fewer trans-



SECTION THROUGH THE SCREW ENGINE.

verse and more longitudinal frames in many vessels. The Isherwood system, now on trial, and claiming to give a minimum of weight of material with a maximum of structural strength and internal space, is practically a return to the longitudinal system of the *Great Eastern.*

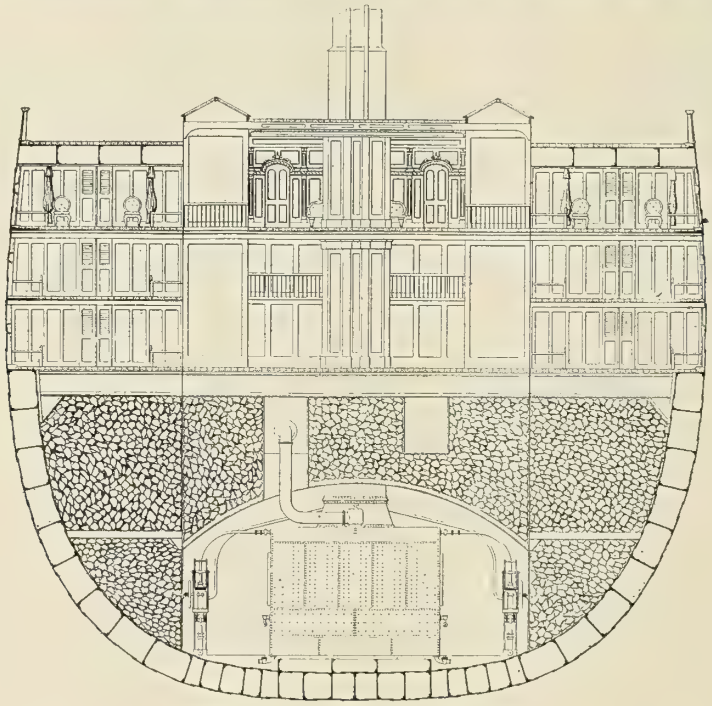
As regards the details of construction of this remarkable vessel, a marked simplicity and uniformity were observed. With the exception of some necessarily heavier scantlings at bow, stern and keel plates, all of the plates used were of equal size, 10 feet by 2.75 feet, and of two thicknesses only, .75 inch and .5 inch, while nearly all the angle-bars used were 4 inches by 4 inches by .625 inch. Further, the laps or seams of plating were single riveted throughout, the butts only being double riveted. All rivets were .875 inch diameter and spaced 3 inches apart.

As is well known, the *Great Eastern* had three distinct means of propulsion—viz.: sails, paddle and screw. That the former were not considered of subsidiary importance in a vessel designed for round-the-world voyages, may be judged by the fact that the six masts, five of which were of iron, carried about 6,500 square yards of canvas. The main yards were 124 feet long, 33 inches in diameter, and weighed about 16 tons each, the largest ever constructed.

As indicated in the longitudinal section, the paddle engines were placed about 'midships. They were designed and built by Scott Russel, who always professed a marked preference for the oscillating-cylinder type for this purpose. Their general character may be gathered from the cross section. There were four cylinders, working in pairs upon two cranks set at right angles. Each pair was inclined at a mean angle of 22.5 degrees from the vertical, and formed a complete engine in itself, with independent condensers, gearing, etc., friction clutches being provided for hand use when necessary to disconnect. Each cylinder had a diameter of 74 inches and a 14-foot stroke, and their immense size may, perhaps, be better realized by explaining that with rod and piston each weighed 38 tons. Gridiron slide valves with relief frames were used, one at each end of the cylinder, to reduce the length of steam passage. Cylinders and valve casings were jacketed with steam supplied at 60 pounds pressure from auxiliary boilers.

Steam to the engines was supplied at 24 pounds pressure from four double-ended tubular boilers, containing a total of forty furnaces. The original paddle-wheels were the largest ever made, each being 54 feet diameter, and weighing, with floats, over 90 tons. With about 10.75 revolutions per minute and 3,400 indicated horsepower, a speed of 7.25 knots was realized under paddles alone, the coal consumption being 6 tons per hour.

The screw engines were located near the after-end of the ship, and were of the direct-acting type, made by Messrs. Jones, Watt & Company, Birmingham. They consisted of four cylinders, placed horizontally, two on each side of the shafting. Each had a diameter of 84 inches and a stroke of 48 inches. The arrangement of connecting rods was peculiar. Double piston rods were fitted to each cylinder, carried by a common cross-head running in guides. To the cross-heads on the left-hand set of cylinders were double-connecting rods, while to the right-hand set were single ones only. As there were but two cranks, each pin, therefore, carried three connecting rods. Condensers of the jet type were adopted, one to each cylinder, and were cleared by horizontal air pumps. The slide valves were gridiron pattern, and were carried, owing to their great weight, on rollers. The valves of opposite cylinders were joined by a frame controlled by link-motion reversing gear; this was worked either by steam or powerful hand screws. Six double-end tubular boilers of the box type supplied steam at 25 pounds pressure from a total of 72 furnaces. The single, four-bladed propeller of 24 feet diameter weighed 36 tons. With about thirty-eight revolutions per minute and 4,800 indicated horsepower a speed of 9 knots was attained by screw alone. When proceeding under paddles or sails alone, the screw-shaft was disconnected, and two 20-horsepower auxiliary engines kept the propeller in motion. With screw and paddles in use a speed of 15 knots was reached, with a coal consumption of about 12.5 tons per hour. She had a capacity for 6,000 tons of cargo and 10,000 tons of coal.



SECTION THROUGH THE BOILER ROOM.

The arrangement of coal bunkers is well shown in the cross sections of the vessel, which are reproduced from Scott Russel's monumental treatise on shipbuilding (1864).

Some important events in the career of this famous ship may be briefly chronicled. The first keel plates were laid in May,

1854, and the vessel was ready for launching in October, 1857. Owing largely to the experiment of using iron launching ways, in place of wood, there was considerable difficulty in getting the great broadside hull, weighing 12,000 tons, into the water. This operation lasted three months, and caused financial difficulties, which in turn hindered rapid progress of work upon the ship. She made her first trial trip in September, 1859, and her first trans-Atlantic voyage in 1861. An accident at about this period tested the efficiency of her double skin. Striking some submerged rocks she ripped an opening some 85 feet long and 4 feet wide in her bottom plating, but proceeded safely to her destination. After several unremunerative trips to New York she was utilized by the British Government for the conveyance of troops. Her accommodations provided for 800 first class passengers, 2,000 second class and 1,200 third class, or a total of 10,000 troops could be carried.

From 1865 to 1873 she did some useful work in laying submarine cables in various parts of the world, after which she lingered as a show shop around the coasts until 1888, when she was sold to the ship breakers at the price of old iron.

The commercial failure of this great vessel was undoubtedly partly due to the fact, as asserted by Scott Russel, that "she was the victim of experiments which had nothing to do with her original design." It must not be overlooked, however, that she never realized her estimated speed by several knots. Her machinery was not powerful enough to drive either set of propellers at efficient speed, and her coal consumption, per nautical mile traveled, was excessive. Overhauled and fitted with twin-screw machinery of modern make she probably could have been usefully employed down to the present day.

Until the commencement of the present century the *Great Eastern's* huge dimensions were unrivaled in the shipping world. When the White Star Liner *Oceanic* broke this half century's record her achievement was associated with commercial success. G. P.

The Introduction of the Screw Propeller Commercially.

The screw propeller was introduced simultaneously by Smith in England and by Ericsson in the United States. Each considered himself the inventor of the screw propeller, and each took out patents in England in 1836 and in the United States two or three years afterwards. Each built small screw vessels in England that were successfully tried in 1837, Smith's being of 6 tons burden, with a wooden screw driven by a 6-horsepower engine, and Ericsson's, named the *Francis B. Ogden*, having about double the tonnage and power. Each built larger screw vessels that were successfully tried in England in 1839. Smith's vessel, the *Archimedes,* which was upward of 200 tons burden and driven by 90-horsepower engines designed by Rennie, circumnavigated the Island of Great Britain in May, 1840. Ericsson's vessel, the *Robert F. Stockton,* smaller, and with less power, was tried in England under steam, and then in April, 1839, crossed the Atlantic under sail. Each introduced the screw propeller on merchant vessels in 1840, and each introduced the screw propeller on war vessels in 1843—Ericsson on the *Princeton* and Smith on the *Rattler*.

Ericsson's propeller, as applied to the *Robert F. Stockton,* consisted of two screws, one right and the other left-handed, placed one behind the other, the aftermost one being operated by a shaft passing through the shaft of the forward one. The rudder was placed forward of the propellers. This arrangement was not successful until one of the screws had been dispensed with and the rudder placed aft of the propeller. The form of the propeller itself, though fairly effective, was inferior to the ordinary screw now in use. It consisted of a cylinder, to the outside of which the blades were attached.

Prior to 1836, when patents for the screw propeller were taken out by Smith and Ericsson, the subject of crossing the Atlantic Ocean by steam had been widely discussed on both sides of the ocean, and steps had been taken for regular communication across the ocean by means of paddle steamers. This was effected in 1838 by the *Great Western,* but the difficulties of the paddle-wheel for ocean navigation were then, as now, generally admitted, so that from this time on a decided impetus was given to the development of the screw propeller for ocean navigation.

THE ADVANCE OF MARINE ENGINEERING IN THE EARLY TWENTIETH CENTURY.*

BY ARTHUR J. MAGINNIS.

It is not out of place to note this review as being that of a new century, owing to the coincidence that it practically relates the advance of entirely new departures from the well-known forms of reciprocating and piston engines which hitherto were embraced under the simple name "mechanical engineering." This will be clearly demonstrated by the fact that, after consideration, it is found to be unnecessary in any way to touch upon the numerous intricacies and doings of reciprocating machinery, but at once to proceed to the consideration of the new form of marine engineering, which, so far as the merchant service is concerned, commenced with the twentieth century.

The first turbine-driven craft appeared in 1894, and, after various developments, it in 1896, under the name of *Turbinia,* attracted marked attention.

Notwithstanding the excellent performances of the *Turbinia* in 1896, it was not until 1900 that the first order for a real test of this form of propulsion for a commercial venture was placed. This was given by a syndicate headed by Captain Williamson, owner of one of the Clyde River services, and in June, 1901, the *King Edward* commenced plying; it was so successful that it was followed soon afterwards by the *Queen Alexandra* in 1902. Since then a rapid adoption of the system has taken place, turbine steamers having practically superseded all others for rapid Channel services, and also for ocean-going passenger vessels of considerable speed, the first Atlantic liner fitted being the Allan liner *Victorian* in 1904, followed in 1905 by the Cunard liner *Carmania,* and the same company's *Lusitania* and *Mauretania* in 1907.

From Table I. it will be seen that practically no advance or improvement has been made in consumption of fuel since 1901, but the adoption of turbine machinery, although not actually improving upon the consumption per indicated horsepower, has brought about an advance, by the fact that it has enabled greater speed to be obtained.

TABLE I.

AVERAGE RESULTS OF MARINE ENGINES.

Boilers, Engines, and Coal.	Average Results: Turbines.				
Year	1872	1881	1891	1901	1909
Boiler pressure, pounds per square inch	52.4	77.4	158.5	197.	195
Heating surface per square foot of grate, square feet	....	30.4	31.	38 and 43*	as 1901
Heating surface per I. H. P., square feet	4.41	3.917	3.275	3.0	as 1901
Coal per square foot of grate, pounds	....	13.8	15.	18 and 28*	as 1901
Revolutions per minute, revolutions	55.67	59.76	63.75	87.	......
Piston speed, feet per minute	376.	467.	529.	654.	None
Coal per I. H. P. per hour, pounds	2.11	1.83	1.52	1.48	as 1901
Average consumption on prolonged sea voyage, pounds	....	2.	1.75	1.55	......

*Natural and forced draft respectively.

* From a paper read before the Institution of Mechanical Engineers, July, 1909.

Up to the present time but little progress has been made in the adoption of turbines for slow-going merchant or other vessels, owing no doubt to the difficulty of applying the turbine to the single propeller, but in no other field of operation is there such an opening for a simple form of rotary machinery. When, however, it is borne in mind that it has taken over seventy years to render all parts of the reciprocating marine machinery fit for the work, it cannot be gainsaid but that in a few years the difficulties yet to be experienced will be surmounted by the adoption of the turbine in the cargo steamer.

TURBINE MACHINERY FOR CARGO VESSELS.

In full-lined vessels of the single-screw "tramp" type, the speed of revolutions of the propeller is not so great as to allow of the propeller shaft being driven direct from the turbine rotor, so that it seems as if even for this class of vessels it would be necessary (notwithstanding the increased first cost) to adopt twin or even triple screws.

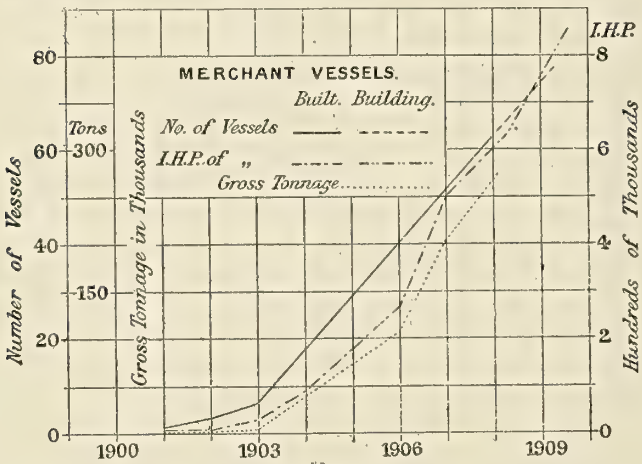


FIG. 1.—CURVES SHOWING NUMBER AND HORSEPOWER OF TURBINE-DRIVEN MERCHANT SHIPS BUILT AND BUILDING.

It may be remembered that when multiple cranks were first adopted, it was generally remarked by those who knew that multiple cranks were all very well for high-speed mail boats, that three-crank engines would not suit the cargo tramp; whereas to-day they are fitted in all sorts, from trawlers, drifters, etc., and even five-crank engines are now found on cargo boats and six cranks on express liners. Bearing this in mind, there does not seem to be an insuperable objection to apply the turbine to slow-speed vessels by the adoption of multiple propellers, say three, as on moderate-speed liners. These propellers, smaller in diameter than the present single or twin screws, running at such speed of revolution as would allow of direct connection to turbines, could, in the author's opinion, be applied, and at but little, if any, more first cost than in existing practice; for although the cost of three lines of shafting is to be met, they would be much smaller and lighter, and the advantage of the boiler pressure being much lower would enable considerable saving of cost and weight to be gained.

ADVANTAGES OF TURBINE MACHINERY.

The marked advantages of turbine machinery in all the numerous vessels fitted up to date is so evident that it will be worth while enumerating them here, in order to point out the desirability of an early effort being made to apply them to the class of vessel now under consideration:

(*a*) The rapid changes of motion (twice per revolution) being done away with, the risk and liability due to fractures or flaws caused by concussions and shocks is altogether eliminated.

(*b*) The absence of piston rods, glands, slide valves, guides, cross heads, connecting rods, link motion and crank shafts removes all risk of undue heating and distortion of parts.

(*c*) The steady revolving motion on the shafting reduces the risk of breakage of shafts and propeller blades to a minimum, and also allows of less supervision, so that the men in charge can devote more time to the firing and working of boilers, etc.

(*d*) The avoidance of risk of serious breakdowns caused by racing in heavy seas.

(*e*) The marked economy brought about by the very great reduction in the use of consumable and other stores, such as oil, packing, etc.

(*f*) The saving in men's time in opening and adjusting and general overhauling.

(*g*) The avoidance of an extensive outfit of tools and gear necessary to effect the work.

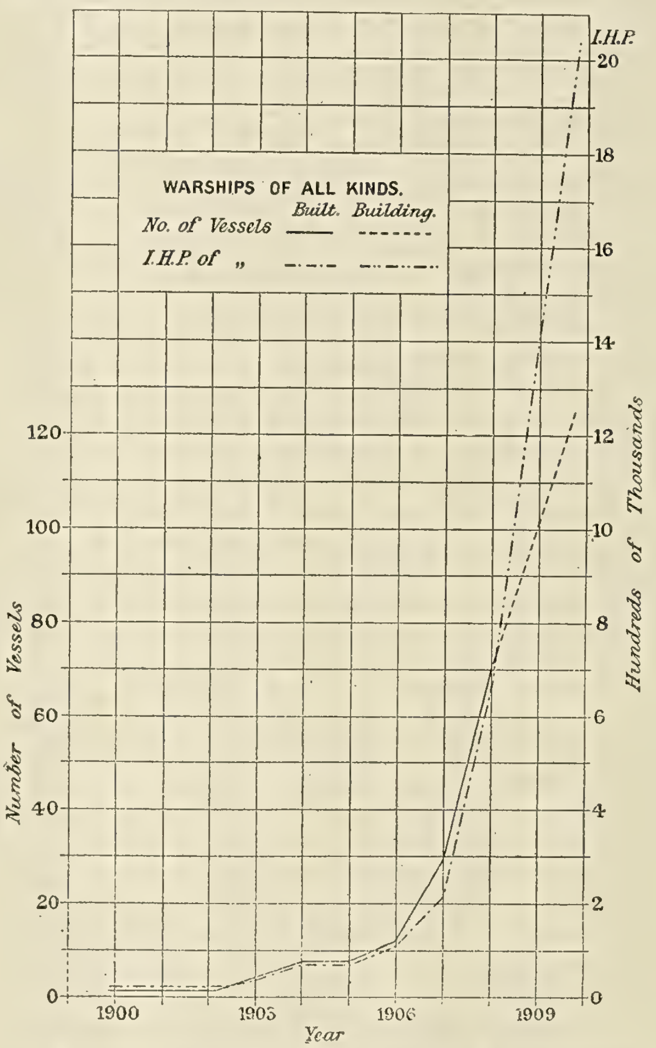


FIG. 2.—CURVES SHOWING NUMBER AND HORSEPOWER OF TURBINE-DRIVEN WARSHIPS BUILT AND BUILDING.

(*h*) The reduction in first cost of many spare parts which must be carried for piston machinery in case of a break-down.

(*i*) The lowering of boiler pressure, which has allowed of an extensive reduction in weight and first cost.

(*j*) Another advantage is that the past eight years have shown that the Parsons turbine machinery will not break down or stop. From extensive enquiries which the author has made, notwithstanding that there are now over seventy steamers continuously plying to and fro, no sailing schedules have been upset by a failure of machinery up to the present, nor has a turbine steamer ever had to be towed into port.

On the other hand, beyond the difficulty of keeping down the

speed of propeller revolutions to suit the turbine, the objections against its adoption are not very serious; apparently some cargo space will be absorbed by having two or three tunnels aft, but this can be partly compensated for by a considerable reduction of engine-room opening through the decks upward. The risk of breakage of propeller blades will no doubt be put forward; but this all recent experience has shown in reality is no greater than with the single propeller.

By consideration of the foregoing facts, it will be seen that the only (but naturally the most important) feature which has so far been against the use of turbines for cargo boats, is the mechanical one of relative speed of turbine rotor and propeller, and this problem will undoubtedly gain much attention in the near future.

In order to show how rapidly turbine machinery has come to the front, Figs. 1 and 2 have been compiled, and from these it can be seen that the adoption of turbine machinery for main propulsion has been extremely rapid, rising in the merchant service from one steamer and 3,500 horsepower in 1901 to sixty-four steamers and 603,200 horsepower in December 1908. There is no doubt that the adoption will become increasingly rapid in the future as the system spreads among all classes of steamers.

COMBINED PISTON AND TURBINE MACHINERY.

An instance of the striving after improvements on the machinery of steam vessels is illustrated by Fig. 3, which is an outline arrangement of the combined system of piston and tur-

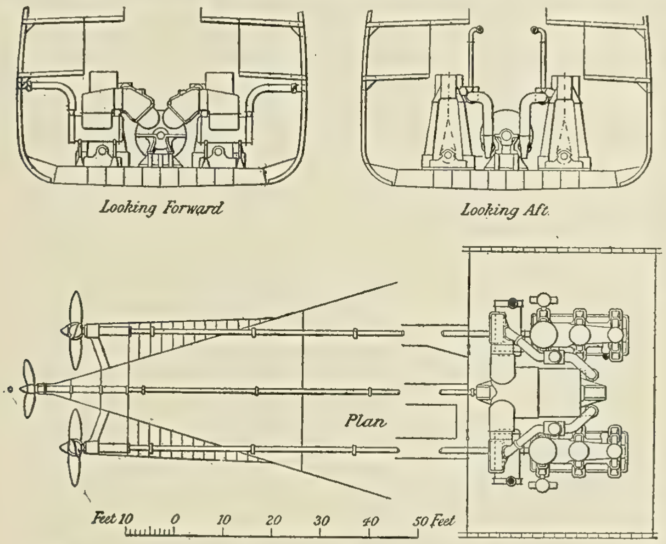


FIG. 3.—ARRANGEMENT OF COMBINED RECIPROCATING AND TURBINE ENGINES ON T. S. S. OTAKI.

bine engines recently built by Messrs. Denny, of Dumbarton, for the direct New Zealand service. This was fitted on the steamship *Otaki* of the New Zealand Shipping Company, London. The adoption of this combination has been brought about by the efficiency of the turbine system when working on the vacuum, as the terminal pressure in the low-pressure cylinder of either triple or quadruple machinery is, as a rule, so high that it has been found there is power enough remaining to drive another or third propeller before allowing the exhaust steam to reach the condenser.

The opportunity of being able to ascertain what superiority may be in this arrangement over that of ordinary piston engines was taken advantage of by Messrs. Denny, who built one steamer named the *Orari* for the New Zealand Shipping Company, and on a second one being required they induced the owners to adopt the turbine-combined system in the second boat, both vessels having the same boiler power and being built off the same lines. The result of the trial trip, which took place in October, 1908, showed a slight increase in speed of about half a knot over that of the *Orari,* and so far as can be ascertained this advantage has been maintained in the regular trade. As these twin vessels are like the *Caronia* and *Carmania,* and also the *Laurentic* and *Megantic,* of special interest for comparative purposes, it may be of some service to note their particulars:

So far as these combined piston and turbined-engined vessels have been at work, satisfactory results have been obtained; but it is evident that an extensive adoption of this system will not be made, the days of the steam piston engine for marine propulsion being numbered.

Coming now to the mechanical details of turbine propulsion, it must be noted how few there are to discuss compared with the very numerous details of piston engines. The only detail in the Parsons turbine machine since the shape and formation of the blades in both the stator and rotor have been fixed by its inventor, is the fastening of the blades or vanes, and this is of such a simple nature that all difficulties have been surmounted, and so far as the turbine proper is concerned the wear and tear are trifling. No doubt in some cases trouble has been experienced in straining in the rotors, due to centrifugal action, and it has been found that rapid corrosion in certain parts has taken place, but a few years' further experience will probably solve and effectually remedy these and some other minor defects which have occurred.

CONDENSERS.

The obtaining of as perfect a vacuum as possible being a special factor in steam rotary engines, the question of an efficient condenser becomes all important, and it is remarkable that almost simultaneously with the coming forth of the turbine the first real efforts were made to improve upon the ordinary surface condenser existing since the days of Hall, who introduced it in 1831, and actually had it fitted on the paddle-steamer *Sirius* in 1837, and on the early Atlantic liner *British Queen* in 1839. After considerable study and experimenting of the condenser problem, it is a matter of common knowledge that it is only a few years ago that this question was given the great consideration which so important a matter deserved. After considerable study and trials, most inter-

TABLE II.

Year.	STEAMER.	Length.	Breadth.	Depth.	Diameter of Cylinders. H. P.	I. P.	M. P.	L. P.	Stroke.	Diam. of Turbine.	Boiler Pressure.	No. of Propellers.
		Feet.	Feet.	Feet.					Inches.	Inches.	Lbs.	
1908	Otaki	465.4	60.3	31.3	24½	...	39	48	...	39	200	3
1906	Orari	460.7	60.2	31.3	2 of 24½	...	2 of 41½	2 of 69	48	None	200	2
1905	Carmania	650.4	72.2	40.0			Tur	bine			195	3
1905	Caronia	650.	72.2	40.2	39	54½	77	110	66	None	210	2
1909	Laurentic	550.	67.3	32.9	2 of 30	2 of 46	...	4 of 53	54		...	3
1909	Megantic	550.	67.3	32.9	2 of 29	2 of 42	2 of 61	2 of 87	60	None	...	2

esting results were obtained by Mr. D. B. Morison, who, acting in conjunction with Professor Weighton, succeeded in discovering hidden defects and placing the designs of condensers, Contraflo and others, on a satisfactory footing, and fully explained them in various papers read before kindred institutions. These improved condensers, with the addition of the modern improved air pumps and the vacuum augmentor of Mr. Parsons, have ensured satisfactory working and have helped to hasten the adoption of the turbine.

SHAFTING.

Owing to the adoption of balanced-piston engines and the turbine principle, the shafting of modern vessels has now almost ceased to be the source of anxiety and trouble known in the past, the shocks and uneven straining being almost altogether eliminated, so that it is unnecessary to comment upon this section of marine machinery.

PROPELLERS.

With regard to the propeller itself little can be said, as the design and style of construction have now settled down to recognized types for the various classes of vessels. It is yet largely only by trial and result that the best propeller can be found for each vessel.

BOILERS.

Coming now to the steam generator, and looking back since the last time marine engineering was brought before the Institution in 1901 by Mr. McKechnie, it is not possible to note any advance or change in the design, as no marked alteration has taken place; but the improvements in the manufacture and working of larger boiler plates have resulted in the still further reduction of riveted parts The introduction of automatic circulators, fitted inside the boilers without any working parts whatever, has materially reduced the repairs rendered necessary by the abnormal strains set up by the varying temperatures prevailing in different parts of the boiler.

In considering this question of boilers, one must not omit to call attention to the still further advantage to be gained by the adoption of turbine machinery, owing to the fact that lower steam pressure is required. What this means in saving of weight over the scantlings necessary for the boilers of quadruple and the later triple-expansion piston machinery can be fully realized when it is considered that in the case of the *Lusitania* and *Mauretania* the saving in weight on the boilers alone is about 120 tons over and above that which would have been required if triple or quadruple-piston engines had been used. This also applies in the case of the cross-channel vessels, such as the Isle of Man steamer *Ben-my-Chree,* to be seen at the Liverpool Landing Stage, the scantlings in this vessel being something like 75 tons less weight than would be required for piston machinery of equal power.

MECHANICAL STOKING.

A detail of considerable importance to the boiler room is that of the adoption of mechanical stoking of some description. This, like other subjects, has been the cause of numerous experiments and patents, but so far it cannot be said to be so satisfactorily solved as to ensure universal adoption. The fairly wide adoption of forced draft has, however, increased the difficulty, and this is much to be regretted, for there is no doubt that the want of some system is badly felt which could modify or completely do away with the arduous requirements of the stokehole of all steamers.

WATERTUBE BOILERS.

Watertube boilers have been put to work on warships, torpedo craft, and in some cases merchant vessels, but, for the most part, for the various craft associated with royal navies outside the fighting line, the Scotch or tank form of boiler is generally adopted, as also in all royal yachts and other pleasure craft. So far as the mercantile marine of the world is concerned, there are no more than 250 vessels of all classes of 300 tons and upwards fitted with watertube boilers, and of these about fifty are passenger and the remainder of the ordinary cargo type.

FUEL.

Coming now to the important question of the nature of the fuel used, even here it is to be regretted that no great advance has been made; true it is that in certain trades and on steamers favorably situated to obtain oil fuel progress has been made, but up to the present there is no pronounced sign that liquid fuel will generally supersede coal. This is much to be regretted, as there is no question but that liquid fuel presents many features to recommend its adoption for marine purposes.

Considering the advantages of oil fuel, as demonstrated from practical experience in naval and other ships, it must be admitted that if steam is to continue as the great motive power for marine propulsion, liquid fuel will sooner or later become more general, especially if the price of the material can be kept down in proportion to the large increase in consumption which must of necessity follow if it be adopted.

INTERNAL-COMBUSTION ENGINES.

Following upon the subject of liquid fuel, there naturally comes the question of internal-combustion engines, which are now being widely adopted for smaller craft and also for barges. Numerous designs for different kinds of fuel are now being put to work, and are gradually being made use of in all parts of the globe, but up to the present no ordinary cargo vessel of 1,000 tons or upwards has been so fitted, but, like other branches of marine engineering, the striving after greater economy will no doubt bring further developments.

Following upon the liquid-fuel internal-combustion engine comes the very important one of using gas generated on board the vessel. Of this it is difficult yet to express a decided opinion, as, with the exception of the now well-known suction-gas vessel *Rattler,* but little experience has been gained, and that only on smaller craft; at the same time consideration of the subject tends to raise hopes that a gradual introduction of the system may soon come about.

That a considerable number of wants for this class of machinery have yet to be surmounted cannot be denied: The want of simple and reliable reversing of propeller, ready provision for working all the numerous auxiliaries, providing heating apparatus and simple working appliances for cargo and such like, present great but not insuperable difficulties.

DIRECT ELECTRIC DRIVE FOR PROPELLERS.

The fact that the coming power for marine propulsion must be directly rotary, coupled with the success of the steam turbine, has brought forward another system, which, in the author's opinion, will soon be widely adopted, namely, the application of electric power direct to the propeller shafts. In view of the fact that up-to-date steam still remains the most simple and most useful source of power available on board ship, and can, thanks to turbine machinery, be readily and economically put to generate electricity up to great power, it will not be out of place to note the advantages likely to accrue from the adoption of direct electrical shaft drive.

In the first instance, reversal of the propeller with full, effective power is attained and readily effected. Secondly, the design of both the steam and electric plant can be so modified as to enable the naval architect to make better and more profitable arrangements for both passenger and cargo space.

The application of the electric drive and form of motor have now been so improved as to reduce wear and tear to a minimum, and has also increased the efficiency, so that prompt and reliable starting, reversing and stopping are ensured.

Owing to the fact that the lower boiler pressure can be used by the steam turbine generator, it is anticipated that the weights of the steam and electric plants together will not exceed that of the present system of reciprocating machinery, and it is also estimated that the first cost will average about the same. Of the advantages of this system one which will commend itself to the navigating department is that the long-looked-for apparatus to control the movements of the propellers direct from the bridge may be obtained.

Another advantage is that electricity, like steam, is capable of being readily applied to all the other requirements on shipboard, such as steering, windlass and winch work, combined with the further advantages of more economical distribution and giving a simple and agreeable artificial light throughout the vessel. Its principal application would, of course, be to the slower-going cargo tramps with propeller speeds of from 70 to 120 revolutions per minute.

Should this system of main electric drive for working screw propellers direct come about, the continued decrease in the boiler pressures, as commenced with the steam-turbine machinery, will no doubt be further continued, and even lower pressures than now exist will be made use of, which will largely decrease the weight of boiler installations and so cheapen the first cost.

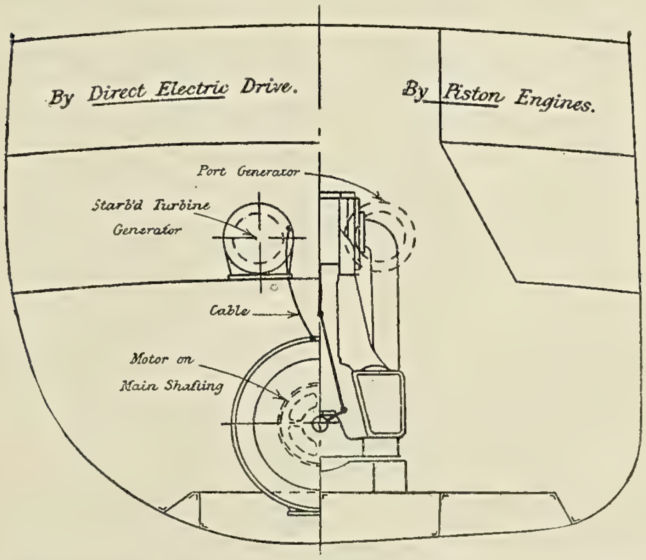


FIG. 4.—DIAGRAM SHOWING RELATIVE SPACE OCCUPIED BY TURBO-ELECTRIC AND RECIPROCATING ENGINES.

Looking back to the papers previously read on this subject, it will be seen that no such remarkable changes have taken place since the introduction of steam navigation as during the few years which have passed since the commencement of the present century. In none of the previous papers has even an allusion been made to the likely use of the internal-combustion engine or the suction gas for marine propulsion, and only in the last paper read by Mr. McKechnie in 1901 was mention made of the Parsons turbine, which is the first successful adoption of rotary instead of reciprocating or piston machinery.

Coming, finally, to the results attained by marine engineering to date they may be summarized as follows: Vessels of close upon 800 feet in length and over 38,000 tons displacement are being propelled across the Atlantic at an average speed of 25½ knots by turbine machinery working up to about 70,000 horsepower having a consumption of upwards of 1,000 tons per day. Similar results have been given in the turbine-propelled warship *Indomitable* of over 40,000 indicated horsepower, and maintained across the Atlantic with watertube boilers.

So far as the merchant marine is concerned, there is at present no sign that the great horsepower of the *Lusitania* and *Mauretania* will be exceeded or even equaled for some years to come, as the large vessels now under construction for the White Star Line, following the types of the vessels constructed by them during the past twenty years, are reported to have but a moderate speed of about 20 knots, so that the machinery installations will be only of very moderate dimensions and power. This latter course is also being followed by the Continental lines, all their more recent vessels not exceeding 18 knots.

RECENT WARSHIP DEVELOPMENT.

BY BENJAMIN TAYLOR.

One of the most appalling things to the economist in fiscal affairs is the rapidity with which costly warships become obsolete and have to be scrapped. Yet this apparent waste of public money is not all actual waste, and in the evolution of new types the highest technical skill in marine architecture and in engineering is evoked. In a survey of recent developments, however, it is not necessary to go back many years, since vessels which were the wonder and talk of the day, say, five years ago, are now slipping out of date. Let us, then, not go further back than 1907 and see what has been the evolution in warship production, and more especially in British shipyards.

The shipbuilding output of the British Admiralty establishments in 1907 was 37,200 tons displacement in two battleships of the *Dreadnought* class, and the contract yards (that is to say the private shipbuilding yards who build on government contracts) launched eighteen armored and unarmored vessels of 79,000 tons displacement for His Majesty's fleet. In addition, for their own ships and for the dockyard-built ships, engineer contractors constructed turbines of an aggregate indicated horsepower of 325,000, guns, gun mountings, armor and auxiliary machinery. The activity of the Admiralty dockyards is not to be measured by new work, because the establishments exist mainly for the maintenance and repair of the fleet. The details of the two ships launched by the government dockyards in 1907 are shown below:

Vessel.	Type.	Displacement, Tons.	Built at
Bellerophon	Battleship	18,600	Portsmouth.
Temeraire	Battleship	18,600	Devonport.

The turbines for the *Bellerophon* were constructed by the Fairfield Shipbuilding & Engineering Company, Ltd., Glasgow, and the turbines for the *Temeraire* by R. & W. Hawthorn, Leslie & Company, Ltd., Newcastle-on-Tyne. The turbines for the sister ship *Superb*, built by Sir William Armstrong, Whitworth & Company, Ltd., Elswick-on-Tyne, were constructed by the Wallsend Slipway & Engineering Company, Ltd., Wallsend-on-Tyne. Each of the three installations was of 23,000 indicated horsepower.

The ocean-going destroyers *Cossack, Tartar, Mohawk, Ghurka* and *Afridi* represent certain remarkable achievements in 1907. All these vessels have excelled the designed speed of 33 knots, and have demonstrated their capability of maintaining it for over 1,500 nautical miles. They are driven by Parsons turbines, and use oil fuel exclusively. They represent ideal "scouts," as they have enormous speed, a wide radius of action, and are capable of keeping most seas with any fleet. The experimental vessel *Swift* has double the displacement of the 33-knot vessels and double their horsepower. The *Swift* was built by Cammell, Laird & Company, Ltd., Birkenhead, and the *Cossack* was a reproduction. John I. Thornycroft & Company, Ltd., London, built the *Tartar;* J. S. White &

Company, Cowes, the *Mohawk;* R. & W. Hawthorn, Leslie & Company, Ltd., Wallsend, the *Gurkha,* and Sir W. G. Armstrong, Whitworth & Company, Ltd., Elswick, the *Afridi.* The turbines for the last-named were constructed by the Parsons Company, at Wallsend-on-Tyne. The three armored cruisers of the *Invincible* class were completed. John Brown & Company, Ltd., Clydebank, built the *Inflexible* of this class; the Fairfield Shipbuilding & Engineering Company, Ltd., built the *Indomitable,* and Sir W. G. Armstrong, Whitworth & Company, Ltd., Elswick, built the *Invincible.* The turbines for the Tyne-built ship were constructed by Humphrys, Tennant & Company, Ltd., Deptford-on-Thames, a firm which is since extinct.

It is noteworthy in shipyard development that in 1907 the four Imperial dockyards in Japan, at Yokosuka, Kure, Sasebo and Maizuru, were equipped for building warships. Sasebo and Maizuru were of more special service in reconstruction and repairs; and with this end in view these two establishments have been greatly extended. At Sasebo three new graving docks are established, having lengths of 750 feet, 600 feet and 475 feet, respectively. These two dockyards may very readily be made available for construction. The battleship *Satsuma* and the first-class cruiser *Kurama* were launched from Yokosuka; the battleship *Aki* and the first-class cruisers *Ikoma* and *Ibuki* from Kure. Kure attracted special attention owing to the very rapid construction of the first-class cruiser *Ibuki.* From the berth occupied by her the battleship *Aki* was launched only in April. The *Ibuki* was laid down in May, and launched in November, thus occupying only six months in construction on the stocks. The displacement of the *Ibuki* is 14,600 tons, against the *Dreadnought's* 18,000 tons. The time taken with the *Aki* was more prolonged, the cause being that after the ship had been commenced on the stocks a gantry was started and erected across the berth. This gantry has six traveling cranes, three spanning the half breadth and three the full breadth, each capable of lifting 15 and 5 tons, respectively, and electrically-driven in their traversing, fleeting and raising actions. The delay with the *Aki,* thus caused, was one means of the speedy construction of the *Ibuki,* the gantry proving of invaluable assistance in her case.

The next year, 1908, was remarkably interesting in naval shipbuilding, and not often has the scope of ships for warfare had such development. The British *Bellerophon* and the German *Posen,* the British *Invincible* and the German *Blucher,* provided different solutions of the same problems. The swifter vessels should hardly be called cruisers, if a cruiser is a ship detachable from a fleet without reducing its fighting strength. But their inferior protection and superior speed design them for quite other uses. They are not battleships as the *Dreadnought* is. The *Bellerophon* is the latest complete logical development of the battleship, in which the problem is not to get speed alone but to combine efficiently great destructive power at long ranges with protection against all the dangers of naval warfare and large fuel capacity and speed. The *Bellerophon* and *Temeraire* are ideal vessels of their type for the particular work British warships have to do.

BRITAIN'S BATTLE-CRUISER INDOMITABLE.

The *Invincible* and her sisters, again, are modernized ships of the cruiser type. The real cruiser, adapted to the problems of modern warfare, however, is to be found in the *Boadicea.* The *Boadicea* type was developed from the scouts of 1902-3 and 1903-4. The most serious objection to these ships was that they did not carry enough coal, and, therefore, their radius of action was poor. In the design of the *Boadicea* this deficiency was to be made good; yet insufficient coal capacity is still being urged against her. The five *Boadiceas* intended to remedy that defect are some 1,200 tons larger, and are called second-class cruisers. They are fast enough for scouting, but their armament and coal capacity are those of cruisers.

The new classification of the coastal craft as torpedo boats is due to the larger purpose which the torpedo is beginning to serve. In destroyer development it may be noted that in course of construction there are such greatly different types as the 36-knot *Swift,* the 33-knot vessels of the *Afridi, Saracen* and *Maori* type, and the 27-knot vessels of the present

programme. The *Swift* is an experimental vessel of 1,800 tons displacement and 30,000 horsepower, with steam turbines and oil fuel. She is a destroyer with a protected cruiser's seagoing qualities. In her case everything is sacrificed for speed and endurance. She seems the ideal scout, but with wireless telegraphy and telephony perhaps the day of the scout is passing. Anyhow, the *Swift* differs strikingly from other scouts.

The 33-knot vessels under construction are essentially destroyers, although they can serve as scouts. Their specialty is ability to keep the sea in most weathers. The 27-knot vessels of this year's programme are to burn coal instead of oil; but that does not mean that the 33-knot vessels are a failure and that we are reverting to coal and less speed. These projected vessels are, except in fuel, the embodiment of the lessons learned from the earlier vessels. The destroyers of the river class were, on paper, slower than the 30-knot vessels, yet at sea they sailed round the nominally faster vessels. They were larger and they kept the sea better. One of the German destroyers, *G 137*, is credited with 33.9 knots, and the twelve *V's* under construction at Stettin are designed to do 30 knots, but the displacement of *G 137* is 572 tons, and the displacement of the Stettin boats is 670 tons, as compared with 900 tons of the British 27-knot boats, and from 950 to 1,100 tons for the 33-knot boats. The British vessels are bound to be faster in sea work. The development of the submarine is also in the direction of increased radius of action, involving greater dimensions and other qualities. The Russian submarines have Gardner engines, and the two Italian vessels run on either petrol (gasoline) or paraffin (kerosene).

The output of British dockyards in 1908 was as follows:

VESSEL.	Type.	Tons.	Built at
St. Vincent	Battleship	19,250	Portsmouth.
Collingwood	Battleship	19,250	Devonport.
Boadicea	Scout	3,300	Pembroke.
C. 17	Submarine	630	Chatham.
C. 18	Submarine	630	Chatham.

The following is the Admiralty dockyard output in previous years:

YEAR.	Portsmouth.		Chatham.		Pembroke.		Devonport.		Sheerness.	
	Ves.	Tons.	Ves.	Tons.	Ves.	Tons.	Ves.	Tons.	Ves.	Tons.
1908	1	19,250	2	630	1	3,300	1	19,250	..	......
1907	1	18,600	..	......	1	14,600	1	18,600	..	......
1906	1	17,900	1	14,600	..	......	1	14,600	..	......
1905	..	......	1	16,350	1	13,550	1	16,350	..	......
1904	2	32,700	1	10,850	1	13,550	..	......	..	......
1903	1	9,800	..	......	..	......	1	16,350	2	2,140
1902	..	......	2	20,880	1	9,800	2	20,880	..	......
1901	1	9,800	1	14,000	2	23,900	1	14,000	3	3,210
1900	1	2,200	..	......	..	......	..	......	3	3,030
1899	1	15,000	2	17,200	1	4,700	2	30,000	..	......
1898	1	15,000	2	27,950	1	11,000	2	15,085	2	1,020
1897	1	12,950	1	5,800	1	11,000	..	......	1	2,130
1896	3	26,300	1	14,900	1	14,900	2	11,000	2	4,275
1895	2	29,800	2	20,500	1	12,350	3	7,700	..	......
1894	1	5,600	1	14,900	1	1,070	3	3,210	2	1,920
1893	1	4,300	2	5,430	2	8,720	3	9,630	1	4,350
1892	2	18,300	1	10,500	1	14,150	1	4,350	4	3,240
1891	2	21,850	3	24,900	1	14,150	1	3,600	1	3,600
1890	1	2,575	1	1,340	1	2,575	3	12,500	2	1,470

All the large maritime powers in the world are either building or proposing to build capital ships of the *Dreadnought* type. Two have been built for Brazil; the *Minas Geraes* at Elswick, and the *Sao Paulo* at Barrow. Argentine has decided to order similar ships. Germany, the United States, Japan, France and Russia are either building or projecting *Dreadnoughts,* all developing the same naval idea. Some experts condemn the British *Dreadnoughts* as inferior units to the German ships of the *Nassau* class, or the Brazilian ships above mentioned. But the ships of each country are designed by experts working on knowledge that is not common to all.

The British *Dreadnoughts* are designed for the work which British battleships are built to accomplish. With them strength is concentrated in home waters in accordance with a plan that has nothing to do with naval architecture. But the British Empire is world-wide, and a slight disturbance anywhere might render necessary a new concentration of her naval force remote from home waters. Fuel capacity, therefore, is a much more important element of design with her than it is elsewhere. The *Dreadnought* has bunker capacity for 2,700 tons, but later vessels of the type improve on that. All naval powers do not need ships with enormous provision of this kind. Their vessels seem, therefore, to carry too much weight in guns and armor to leave much for coal.

In respect to armor protection there is little to choose between British and German or Brazilian ships. In speed and in fuel capacity the British ships are superior but have fewer guns. The *Minas Geraes* and her sister ship have twelve 12-inch guns with a turret forward and a turret aft, superimposed above another. The Nassau types have fourteen 11-inch guns in seven barbettes, and cruiser *F* will have twelve guns of the same caliber and the same pattern. The chances are that the fighting efficiency, under war conditions, of the *Dreadnought's* ten guns is higher than that of the *Nassau's* fourteen guns, and the *Dreadnought* has greater speed and better coal capacity. The Vickers and Armstrong companies put 12-inch guns on the Brazilian ships. The United States has preferred the 12-inch, while France thinks more of the 9.4-inch than the 12-inch.

The British ships have been improved with the view of making them capable of operating over wider areas without sacrificing qualities essential to success against vessels of corresponding types designed to operate in narrower areas. The general line of progress is more towards perfection of the different compromises than to the reconstruction of them.

THE LATEST UNITED STATES BATTLESHIPS.

The most recent battleships to be completed for the United States Navy are the *Michigan* and *South Carolina,* of 16,000 tons normal displacement. These ships are 450 feet long on the waterline, with a beam of 80 feet 3 inches and a mean draft of 24 feet 6 inches. The full load displacement is 17,650 tons. The ships are designed for an indicated horsepower of 16,500, to give a speed of 18.5 knots. Twelve Babcock & Wilcox watertube boilers, located in three separate compartments, supply steam at a pressure of 265 pounds per square inch. Propulsion is by means of two outboard turning screws, driven by four-cylinder triple-expansion engines. At full power the engines are designed to turn 125 revolutions per minute. The total machinery weight is 1,600 tons. Nine hundred tons of coal is the normal fuel supply, but the bunkers have a capacity for a maximum of 2,200 tons.

The armament consists of eight 12-inch 45-caliber guns, mounted in pairs in turrets on the center line of the ship—four forward and four aft. The secondary battery consists of twenty-two 3-inch 14-pounder rapid-fire guns, and they are distributed on the main and gun decks. There are also two 3-pounder semi-automatic, eight 1-pounder semi-automatic, four .30-caliber automatic, and two 3-inch field guns. Two 21-inch submerged torpedo tubes bring the total weight of armament up to about 1,150 tons.

The main armor belt is 8 feet wide and 12 inches thick amidships. The main redoubt is 300 feet long, and at the ends there is a light belt of 1½-inch armor. The turrets are protected by 12, 10 and 8-inch armor, the 12-inch armor being distributed on the front of the turrets, the 10-inch on the bar-

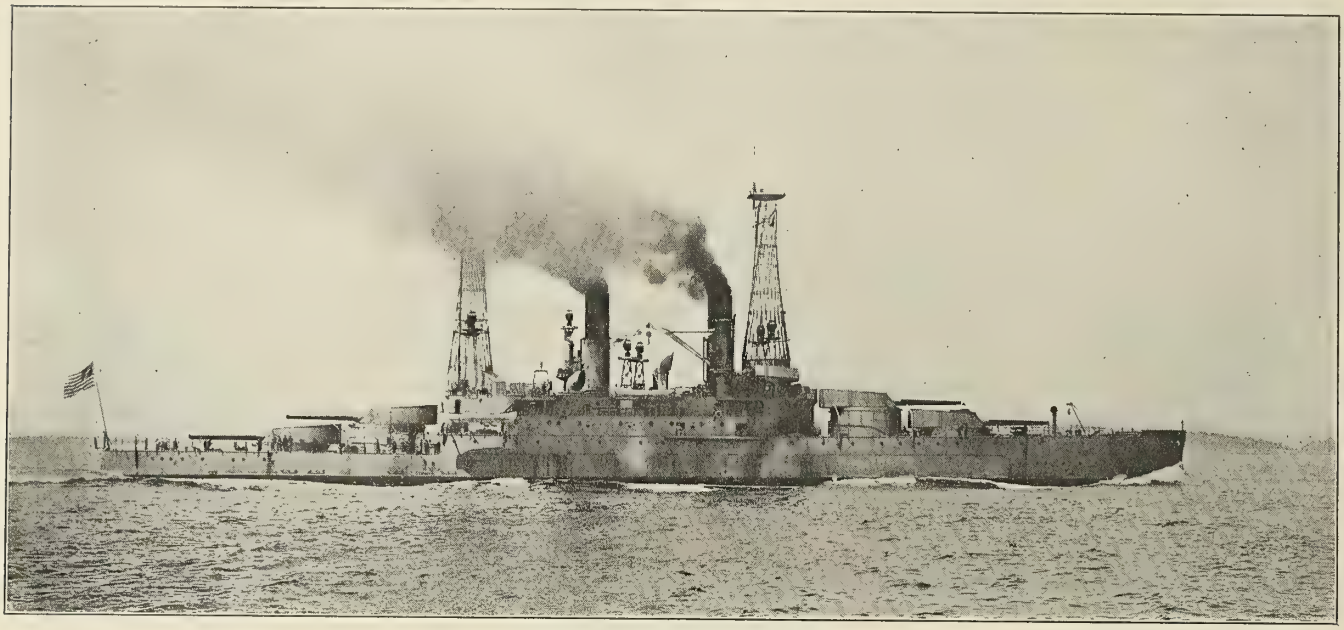
bettes and the 8-inch armor on the sides. The 'thwartship armor bulkheads are 10 inches thick, and the conning tower is protected by 12-inch armor, the total weight of armor being about 4,000 tons.

The *Michigan*, a photograph of which is shown herewith, was built by the New York Shipbuilding Company, Camden, N. J., and the *South Carolina* by the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.

Four still more powerful ships, the *Delaware, North Dakota, Utah* and *Florida*, of 20,000 tons normal and 22,075 tons full-load displacement, designed for a speed of 21 knots, are fast nearing completion. These ships are armed with ten 12-inch 45-caliber guns, all mounted in pairs in the turrets on the center line of the ship, the secondary battery consisting of fourteen 5-inch rapid-fire guns, together with the usual equipment of small guns. The heaviest armor is 11 inches thick

The *Delaware* and *North Dakota* were authorized in 1906, laid down in December, 1907, and are now over 90 percent complete. The *Utah* and *Florida* were authorized in 1907, and laid down the latter part of 1908, and are now over 30 percent complete. These ships are 518 feet 9 inches long over all, 510 feet long on the waterline. Their beam is 85 feet 3 inches, and the mean draft 27 feet 3 inches. Babcock & Wilcox boilers are used in all of the ships, and provision is made for normal supply of 1,016 tons of coal and a maximum supply of 2,340 tons. The designed horsepower is 25,000, and is to be developed in the *Delaware* by two sets of triple-expansion engines, and in the other ships by Curtis turbines.

Powerful as these last-named vessels are there are now authorized two battleships of 26,000 tons displacement and 21 knots speed, carrying a main battery of twelve 12-inch 50-caliber guns, each capable of throwing an 850-pound shell with a muzzle energy of 50,000-foot tons. The secondary battery is to consist of a large number of 50-caliber 5-inch guns. The main features of the design of these ships will be similar to the *North Dakota* type, but the total horsepower will probably be in the neighborhood of 33,000, and a bunker capacity of 3,000 tons of coal will be required. These ships will be the logical development of the *North Dakota* and *Florida* class, the length being increased to 545 feet, beam to 92 feet, and the draft to 29 feet. The addition of another turret containing a pair of 12-inch guns, of course, alters the general arrangement of the vessel somewhat. This additional turret is placed between the two after turrets, as located on the *Florida*, and is sufficiently elevated to permit its guns to fire astern over the aft turret. The main characteristics of modern battleship design are very noticeable in these ships.



UNITED STATES BATTLESHIP MICHIGAN. Photograph by N. L. Stebbins.

THE OLDEST VESSEL IN COMMISSION.

BY AXEL HOLM.

The distinction of being the oldest vessel in commission in the world undoubtedly falls to the little Danish sloop *Constance*. Although she does not look old or old-fashioned by any means, yet she was built in the year 1723. To-day she is still busy as a tramp between Danish ports, seldom failing to get her cargo of flour or lime, and carry it safely over the same Belts and sounds with which she has been familiar for 185 years.

That this particular age is correct was stated by the Danish Bureau of Shipping only a short time ago. Until recently she figured in the official lists without any age at all, but by looking over the archives very carefully, the Bureau could follow her way through the lists under various names down to the very year in which she was built.

Of course, every stick in the hull has not been kept intact, as, for instance, in 1868, she was given a thorough overhaul, during which her stern was altered and lengthened by about 5 feet, but still the greater part of her hull remains from that old time. Her present owner claims that to-day she is in better sailing condition than when he bought her in 1889, as he has spent some $700 (£144) on a new rig, and other renewals. Anyone, however, who has dealt with old-time products in shipbuilding well knows the excellent kind of oak and other materials commonly used; how gloriously it bears its age, and how hard it is, even for the teeth of time to destroy it.

Even at the great age of 180, this vigorous old ship, in the Great Belt between the islands of Lealland and Finen, rescued and carried safely into harbor a sister of hers in distress. She then got the cargo of the others, as she was in ballast herself, and started off for the port of Malmoe, in Sweden. But here she happened to meet the first serious accident of her long life. She was overtaken by a heavy hurricane, which swept all over Denmark, and on Christmas Day, 1902, she grounded and filled with water near the place of

her recent work of rescue. This her owners thought to be her last voyage, but, as a matter of fact, the rough treatment seemed to do her no harm and she is now in service as before.

These facts were told the writer by her present owner and captain, Mr. J. Jeusen, of Lohals, Denmark, to whom she has belonged since 1889. He gave her her present name, and has been nursing and caring for her like a father, his only sorrow being that the old vessel may soon disappear from the lists of the living, as he is an old man and has made up his mind to retire from shipping. As a means to prevent this, however, an attempt is now being made to arouse public interest through Danish newspapers for her preservation as long as possible.

THE DANISH SLOOP CONSTANCE AS SHE APPEARS TO-DAY.

Not very much is known of her earlier history. Until the year 1882, probably under the name *De fire Brödre* (*The Four Brethren*), she belonged to the same family for eighty years, sailed by son after father, and plying between Denmark and Christiania, Norway. From 1882 to 1889 she was owned by Captain C. Böje, of Marstal, Denmark, carrying the name *Catarina* until her present owner obtained her, as previously mentioned.

The government's official list of Danish ships describes her as follows:

Name	*Constance.*
Letters	N. B. L. T.
Rigging	Sloop.
Building place	Aerö, Denmark.
Building year	1723.
Material	Oak.
Depth in hold	6.8 feet.
Tonnage, gross	35.
Tonnage, net	27.
Port of registry	Lohals, Denmark.

The length and breadth is given as 52 feet 6 inches, and 14 feet 8 inches, respectively, but it is not definitely known in what manner these measures were taken.

As may be seen from the illustrations, she does not look very great or imposing, but she has proved that her diminutive size is not to be scorned, as in the long course she has beaten many larger craft. If, for instance, we assume that during 150 years the little *Constance* has made fifty voyages a year, carrying about 30 tons of dead weight each voyage, she will, in all, have conveyed more than 200,000 tons of merchandise, and even the giant *Mauretania* will not soon overtake this record.

As a matter of curiosity, it might be mentioned that under the Danish flag there are plying thirty-two sailing vessels built before 1825, and of these, seven were built before 1800. One of them, the schooner *Vigilant,* was built in Baltimore in the year 1790, and has ever since been in service between the Danish Antilles. During the war between Denmark and Britain, 1807-1814, she fought victoriously as a privateer against the Englishmen.

SKETCH SHOWING RIG OF THE CONSTANCE.

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A Century's Progress in Steam Navigation.

Now that steamships of 20,000 tons and over are no longer an uncommon sight, and with steamships of over 40,000 tons displacement driven by engines developing 70,000 horsepower maintaining an average speed of 25½ knots on regular voyages across the Atlantic, it is hard to believe that all this progress is the result of only a hundred years' experience in steam navigation, that, in fact, it is really the outgrowth of much less time than that, since the real development of steam ocean navigation did not begin until 1840. From 1840 to 1860 the development of the ocean-going steamship was steady, but as paddle-wheels were used almost entirely for propulsion, it was on lines somewhat foreign to the recent rapid development. Since 1860 screw propellers have been used exclusively on trans-Atlantic steamships, and therefore it might very well be said that the swift, modern, luxurious trans-Atlantic steamship has been developed within the memory of living man.

The invention of the steamboat cannot be credited to any one man. Robert Fulton was the first to bring out a successful commercial steamboat, but he was by no means the first to experiment with this means of navigation. In America alone, where at that time the facilities for engine building or machine work of any kind were very poor, no less than fourteen actual steamboats had been built and operated previous to the building of the famous *Clermont*. Some of the ideas evolved by Rumsey, Fitch, Morey and Stevens were far in advance of those which Fulton put into practical operation, and which have since become fundamental factors in the development of modern steamships. Their successes are in no way belittled by Fulton's brilliant achievement, no more than are the achievements of such inventors in other countries, as Hulls, Symington, Watt, and others in England.

After the first experimental period in marine engineering, which resulted in the building of Fulton's *Clermont* in America and Bell's *Comet* in England, only a few years elapsed before a steamship made a voyage across the Atlantic ocean. This was accomplished by an American vessel (the *Savannah*) in 1818, although it was not until 1840 that an attempt was made to establish regular communication by steamship between England and America, when the *Britannia*, of the newly-organized Cunard line, made her first voyage to America. The *Britannia* was only a small, wooden paddle steamer of 1154 tons and 740 indicated horsepower, capable of an average speed of 8½ knots. She was only 207 feet long, 34 feet 4 inches broad, and 24 feet 4 inches deep, but she marked the beginning of what has since become the field of greatest activity and development in marine engineering and naval architecture, the trans-Atlantic steamship. The culmination of this development in the modern turbine-driven greyhound, capable of crossing the Atlantic at an average speed of 25½ knots, is a fitting climax to a century's progress in the development of steam navigation.

During this comparatively brief progress (in reality little more than half a century), the length of steamships has been quadrupled, both the breadth and depth have increased by about 115 percent, the tonnage is nearly 30 times greater to-day than it was then, and the engine power 95 times greater. This increase in dimensions, however, gives but a small idea of all that has been accomplished by the marine engineer and naval architect during this time. Great as has been the development in size, power, speed and luxuriousness of the modern liner, no less remarkable have been the economies effected in the weight of marine engines as compared to their power as well as in their

coal consumption. In the *Britannia* of 1840, the main propelling machinery developed only from 1½ to 2 horsepower per ton weight, and the coal consumption was from 4½ to 5 pounds of coal per indicated horsepower per hour. With the reciprocating marine engines of the present day at least 6 horsepower can be developed per ton weight, and the coal consumption averages only from 1½ to 2 pounds per indicated horsepower per hour. With turbine-driven merchant ships from 12 to 14 horsepower per ton of propelling machinery can be obtained, while for naval vessels still greater economy is obtained. On large battleships about 12 horsepower per ton of machinery can be obtained with reciprocating engines, and about 14 with turbines; on fast cruisers the figures are in the neighborhood of 19 for reciprocating engines and 25 for turbines, while on the modern torpedo-boat destroyer about 45 indicated horsepower can be obtained per ton of machinery with reciprocating engines, and about 65 horsepower per ton weight with turbines. These marvelous results are obtained without any increase of coal consumption; in fact, better economy in this respect is being attained daily. Undoubtedly even better results than these can be obtained in the near future if the problem of reversing steam turbines is simplified, or if more efficient forms of high-speed propellers are devised. This great increase of power per ton weight of machinery is the vital point of all progress in marine engineering and is the particular contribution of marine engineers toward economy in size and cost.

As regards the construction of ships' hulls, there is nothing to-day to limit the size of the vessels commercial considerations demand. Naval architects are now able to design and build vessels of any dimensions which are found necessary to carry on commerce most economically and to suit any harbor conditions which exist. This is made possible primarily by the substitution of steel for iron and wood construction. In the old days of wooden ships the size of ships was limited, because beyond a certain length the structure of vessels was inadequate to withstand the stresses occasioned by the weight of the ships themselves and their cargo. Hogging occurred in many of the larger wooden ships, and this could not seem to be prevented by any form of construction adaptable with wood as the material. The substitution, first of iron and later of steel, for wood has enabled great economy to be effected in the weight of ships' structures. Formerly this structural weight represented perhaps fifty percent of the total weight of a full loaded vessel. If wood had remained the chief shipbuilding material it would have been absolutely impossible to approach the dimensions or speeds which have now been attained. With the steel which is now procurable for shipbuilding material and with the forms of construction which are used, notwithstanding the enormous increase in length, tonnage, and total weight of modern steamships, the proportion of that total weight devoted to the hull structure itself is very much less than it was in the old days of smaller wooden vessels.

To what extent and with what rapidity recent progress in marine engineering has outstripped all previous development is evident when it is considered that at the time the giant turbine-driven Cunard steamships Lusitania and Mauretania were projected the most powerful turbines which had then been tried were those fitted in the third-class cruiser Amethyst, an installation which aggregated only about 12,000 horsepower, or about 4,000 horsepower for each unit. The advance from these turbines to the four turbines of the Lusitania and Mauretania, each capable of developing nearly 18,000 horsepower, or a total of about 70,000, was a step which corresponded practically with the entire development of reciprocating engines from 1860 down to the present day.

Although in the early development of steam navigation most innovations were made in the merchant marine and afterwards copied in naval vessels, yet the same does not hold true to-day. Iron was generally introduced as a shipbuilding material for merchant vessels as early as 1832, but it was not until about 1860 that it was generally adopted for naval vessels. Previous to 1854 all naval vessels were wood-built, unarmored vessels.

The screw propeller, on the other hand, was introduced into both merchant and naval vessels at about the same time in the early forties. Compound engines were not introduced in the British navy until 1871, whereas they had been in use in merchant vessels some years before that. Twin screws were first used in the *City of Paris* and the *City of New York*, of the Inman line in 1889. From 1835 to 1845 vertical cross-head engines, side-lever engines, beam engines and oscillating engines were all introduced in merchant ships and became generally used. The type of engine used in early war vessels was usually either the side-lever, heavy long-stroke engine, such as was used in the *Phoenix* in 1830, and which was popular in the mercantile marine as late as 1860, when paddle-wheels were generally discarded in favor of screw propellers, or the trunk type of engine, which was exceedingly low and compact, having horizontal cylinders and return connecting rods.

What the future has in store in the way of developments in ships and propelling machinery is impossible to predict. At present ships 890 feet long, 92 feet beam, with a molded depth of 64 feet and a displacement of 60,000 tons are under construction; but in point of engine power and speed they do not equal the *Lusitania* or *Mauretania*, although it is very probable that they will show many improvements in economy over these vessels. In the light of recent progress, however, the future promises brilliant achievements.

Progress of Naval Vessels.

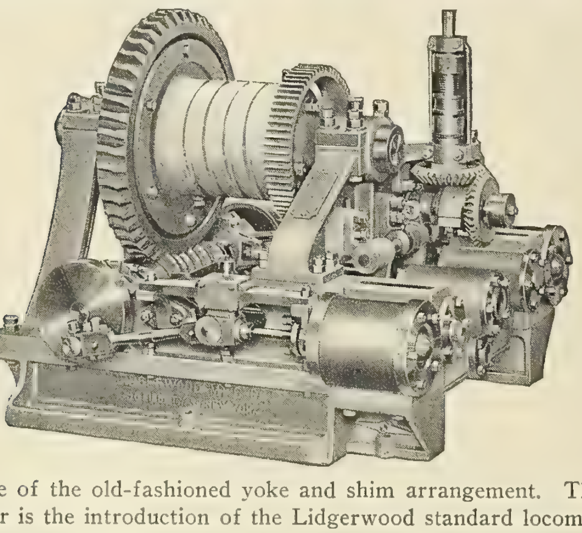
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		July 1.	Aug. 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons	94.6	96.5
Michigan ...	16,000	18½	New York Shipbuilding Co.	98.3	99.4
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	86.9	91.8
North Dakota	20,000	21	Fore River Shipbuilding Co.	87.7	90.3
Florida	20,000	20¾	Navy Yard, New York	19.9	24.8
Utah	20,000	20¾	New York Shipbuilding Co.	26.8	33.2
TORPEDO-BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons	94.6	95.6
Lamson	700	28	Wm. Cramp & Sons	84.9	88.4
Preston	700	28	New York Shipbuilding Co.	82.2	90.1
Flusser	700	28	Bath Iron Works	83.6	90.0
Reid	700	28	Bath Iron Works	79.8	84.2
Paulding ...	742	29½	Bath Iron Works	17.6	21.7
Drayton	742	29½	Bath Iron Works	17.6	20.7
Roe	742	29½	Newp't New Shipbuilding Co.	51.6	57.4
Terry	742	29½	Newp't News Shipbuilding Co.	47.6	51.9
Perkins	742	29½	Fore River Shipbuilding Co.	37.9	44.6
Sterrett	742	29½	Fore River Shipbuilding Co.	35.8	41.2
McCall	742	29½	New York Shipbuilding Co.	17.1	22.5
Burrows	742	29½	New York Shipbuilding Co.	16.7	22.4
Warrington..	742	29½	Wm. Cramp & Sons	23.9	32.7
Mayrant	742	29½	Wm. Cramp & Sons	30.0	37.2
No. 33......	...	....	Bath Iron Works	0.0	1.1
No. 35......	...	....	Fore River Shipbuilding Co.	0.0	0.8
SUBMARINE TORPEDO BOATS.					
Stingray	...	..	Fore River Shipbuilding Co.	94.3	95.0
Tarpon	...	..	Fore River Shipbuilding Co.	94.3	95.0
Bonita	...	..	Fore River Shipbuilding Co.	87.3	90.6
Snapper	...	..	Fore River Shipbuilding Co.	87.1	87.6
Narwhal ...	...	..	Fore River Shipbuilding Co.	93.7	94.5
Grayling ...	...	..	Fore River Shipbuilding Co.	90.1	90.6
Salmon	...	..	Fore River Shipbuilding Co.	81.1	81.8
Seal	...	..	Newp't News Shipbuilding Co.	20.4	23.2
Pickerel			The Moran Co.	3.1	4.3
Skate			The Moran Co.	3.2	4.3

ENGINEERING SPECIALTIES.

New Lidgerwood Steering Engine.

The Lidgerwood Manufacturing Company, of New York, having recently established a marine department, is now building a line of steering engines of approved design, one type of which is shown herewith. This engine is not a radical departure in design from those now in general use. It does, however, contain a number of important features which will be appreciated by practical men. Two of these features are clearly shown in the illustration. The first is the introduction of the Lidgerwood standard gib and key connecting rod in



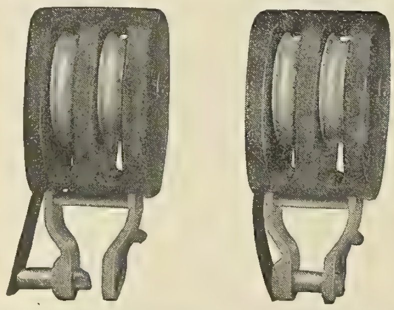
place of the old-fashioned yoke and shim arrangement. The other is the introduction of the Lidgerwood standard locomotive type of cross-head and guide instead of the old-style plug cross-head and barrel guide. The application of these features is not new for ship work, as they have been extensively used on ships' winches for a number of years by many steamship lines of this and other countries.

The arrangement of the engine is such as to permit of the easy adjustment for wear, thereby obviating the disagreeable noise which frequently arises from steering engines after they have been in use for a short while. Great care has been taken in designing the machine so as to obtain the maximum strength of parts where it is most needed. The engine is exceedingly compact, and is arranged for easy inspection and adjustment.

The machine is built from new patterns, in which all the improvements suggested by an extended experience and observation have been embodied. The engine illustrated is an automatic steam-type of steering engine, although the company also builds a combined hand and steam type and also a screw-gear engine for large ships. All of these engines are built on the same general lines and under the Lidgerwood system of duplicate parts, which not only insures accuracy but at the same time makes it possible at any time to promptly procure repair parts which can be put into place at once without requiring any work in fitting.

Wick's Patent Releasing Device for Lifeboats.

A new releasing device for lifeboats has recently been placed on the market by David Kahnweiler's Sons, New York, which is both simple and efficient. The main feature of the device consists of a sliding bolt attached to a spring, which tends to draw the bolt out and release the boat. The bolt is held in place when in operation by the weight of the boat, and is secured by a thumb catch, which serves the same purpose as the mousing of a hook and prevents the automatic device from



operating before it is desired. In launching a boat, just as soon as the weight of the boat is on the sliding bolt the thumb catch can be removed, in which case the bolt remains in position until the boat is water-borne, when it automatically springs out of the way, releasing the boat immediately. If it is desired, the thumb catch need not be removed until the boat is water-borne. The method of operation is so obvious that it requires no experience to use the device. Therefore, it is very unlikely that any mishap could occur with it. Because there are so few parts to the device the block is brought closer to the boat than if fastened in any other way. This allows more distance between the upper and lower blocks for hoisting, so that the davits need not be so high in order to give the requisite clearance. The blocks are made of galvanized iron or lignum vitæ sheaves with bronze rolls.

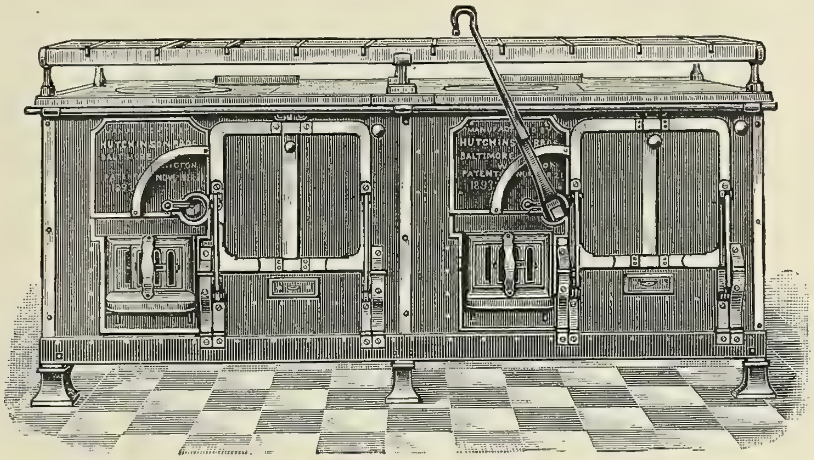
A Remarkable Coaling Device.

Some remarkable records in handling coal on board ship are being made on the United States collier *Mars*. By means of a new device, which is the invention of Spencer Miller, chief engineer of the cableway department of the Lidgerwood Manufacturing Company, New York, two men are able to discharge 117 tons of coal per hour from a single hatch of the collier. Twenty men, manning as many hatches of this new collier, can discharge a thousand tons of coal per hour and over. The entire cargo of the collier can be emptied in about eight hours. This new device, which is called the marine transfer, consists of a clam-shell bucket, which digs the coal from the hold, hoists it, swings it outboard and dumps it onto the deck of a warship, where it is distributed by the ship's crew into the bunkers.

In contrast to such a remarkable performance the present method of handling coal in vogue in all navies seems slow and cumbersome. According to the present method, sailors are sent into the hold of the collier, where they shovel the coal into bags. The ship's winches and derricks hoist the bags and deposit them on the deck of the warship, where they are distributed to the bunkers by the crew. By this method 25 tons of coal per hour per hatch is an average performance and 40 tons is the maximum. This, in fact. can only be accomplished by the aid of about forty men. The advance from handling 40 tons of coal per hour by forty men to 117 tons per hour by two men is indeed a remarkable performance.

Hutchinson's Steel Plate Marine Ranges.

The body of the Hutchinson steel plate marine range, manufactured by Hutchinson Bros., Baltimore, Md., is made of heavy cold-rolled steel strongly riveted and bolted at the joints. All trimmings and braces are made of wrought and malleable iron, highly polished and nickel-plated if desired. The castings, such as the top, grate, fire-plates and water-back, are made of fine quality pig iron. A special feature of the range is the oven bottom, which is made of boiler plate, reinforced with angle-iron, a construction which, it is claimed, is non-warpable. The range is fitted with the Hutchinson patent shaking and dumping grate, suited for burning either hard or soft coal. The grate is so constructed that the fire can be shaken, kept bright and dumped without removing the covers or opening any doors. It is also claimed to be very durable. The range shown in the illustration, which is supplied with guard rails, cross bars, feet and steel flues, also with side braces and rods to bolt to the floor, is 7 feet 6 inches long and 39 inches deep, with two fires and two ovens, each oven being 28 by 18 by 16 inches.



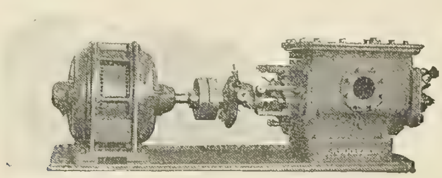
Duval Metallic Packing.

Radical changes have been made in power plant machinery in the last decade; high-pressure steam has almost entirely replaced low-pressure service; superheated steam is being generally used; the internal-combustion engine has proved practical; enormous hydraulic pressures are now carried. All of these improvements have demanded the most exacting performance of packing, and, as the soft compositions of the old days could not meet the new requirements, many different kinds of packing have been placed on the market for this purpose. One of the first of these was the Duval woven wire metallic packing, which is manufactured by the Power Specialty Company, New York.

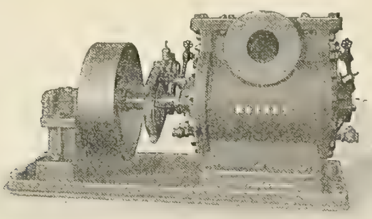
Duval metallic packing is made of a fine, white alloy wire, accurately plaited in square form. This wire is of special composition, determined after extensive experiments and calculated to obtain a maximum strength and elasticity with a minimum friction and wear. It is claimed that it will resist enormous pressures and maintain a tight joint without bearing unduly against the rod, while, at the same time, it is of such hardness that it will not cut the rod or wear unevenly, although if applied to a rod already scored it will adjust itself to the uneven surface. It is also claimed that its heat-resisting properties are such that it cannot burn when submitted to the highest temperatures, and that it does not deteriorate when kept in stock. Its field of service is practically unlimited, for it is designed to maintain a tight joint against any water pressure up to 5,000 pounds per square inch, and also against any temperature up to 900 degrees F. The speed of the rod or plunger has little effect on the packing, as it may be used on rods moving as fast as 1,750 feet per minute or upon slow-speed plungers. It is not recommended for use on brass rods.

An Improved Type of Marine Air Pump.

It is always of first importance to economize on the space occupied by machinery in a steamship. One of the largest auxiliaries which is used is the old-style air pump, which, on account of having large cylinders and operating at slow speeds, takes up an undue amount of space. This is true whether the air pump is of the independently steam-driven beam type or direct connected. A very much smaller pump, known as the Rotrex (Pratt's patent), has just been put on the market by the C. H. Wheeler Manufacturing Company, Philadelphia, Pa., in order to take the place of the old-style large and bulky pump. The Rotrex pump embodies all the essential features of a high-grade, high-vacuum air pump, and is adapted for



direct connection to other auxiliary machinery. The construction of the pump is very simple, consisting of a light-weight cylindrical casing and one rotor, eccentrically mounted on a heavy steel shaft carried in outboard ring-oiled bearings independent of the stuffing-boxes. Division between the suction and discharge in the pump cylinder is made by means of a radius cam, which is carried in independent bearings, and is operated by means of a lever and crank from the rotor shaft on the outside of the pump. These three parts, namely, the rotor, radius cam and driving crank, are the only moving parts in the pump. By this arrangement it is claimed that internal contact, which has hitherto been the cause of the failure of many rotary pumps, is entirely eliminated, the rotor operating with a close clearance from the bore of the pump cylinder and



the cam maintaining a close clearance from the rotor. By an ingenious arrangement of ports these clearances are thoroughly water sealed at all times, insuring a high vacuum. No suction valves are used, and the discharge valves are of the high-speed metallic type, to eliminate expensive up-keep. The pumps are built in capacities from 50 to 5,000 horsepower in one unit, and beyond that size multiple units are used, an independent air-pump engine being provided with one Rotrex pump, driven from each end of the crank shaft and direct connected to the engine. The usual marine arrangement consists of a centrifugal circulating pump driven by a vertical high-class economical steam engine with the Rotrex air pump direct connected. By this arrangement one engine drives both pumps, the speed of the combined outfit being 180 to 250 revolutions per minute, depending upon the size of the unit. This arrangement eliminates the additional steam cylinders ordinarily used to drive an air pump. It is claimed that the Rotrex pump produces the highest possible vacuum which is needed with the latest developments in steam turbines. This is accomplished with a machine of small size, which is impossible with the old-style reciprocating pump.

TECHNICAL PUBLICATIONS.

Compressed Air Work in Diving. By G. W. M. Boycott Size, 6 by 9½ inches. Pages, 116. Figures, 16. London, 1909: Crosby, Lockwood & Sons. Price, $4.00.

This book is intended as a practical hand-book embodying the main principles of compressed air work and diving. Chapters 1 and 2 give a set of rules for stage decompression which will undoubtedly be found exceedingly useful by anyone engaged in this line of work. The method outlined was originated as the result of the work of a committee appointed four years ago by the British Admiralty to report upon the conditions of deep-water diving, and it was also based upon recent investigations of Drs. Haldane and Boycott and Lieut. Damant at the Lister Institute of Preventive Medicine. The subject of diving is included in the first four chapters, the remainder of the book being given over to the use of pneumatic caissons and cylinders, tunneling, etc. In discussing the subject of tunneling, the methods used in constructing the Blackwall, the Rotherhithe and Hudson River and East River tunnels are discussed.

The Screw Propeller. By A. E. Seaton. Size, 6½ by 9 inches. Pages, 255. Plates, 6. Figures, 65. London, 1909: Charles Griffin & Company, Ltd.; Philadelphia, J. B. Lippincott Company.

In the preface the author states that the object of this book is to amplify and explain the subject matter relating to propellers which was given in his *Manual of Marine Engineering* published thirty-two years ago. In that work only general rules and formulæ sufficient to satisfy the wants of designers were given, whereas in the present volume all that is new and of importance regarding the screw propeller, paddle-wheels, hydraulic propulsion, etc., together with much that is of interest, although comparatively old, is taken up. No attempt has been made to include abstruse and highly mathematical investigations concerning the theory of the resistance of ships and propellers, the book being intended more particularly for students, draftsmen, sea-going engineers, designers and the like, who have immediate use for necessary rules and data for the best design of propellers. The subject of the screw propeller itself is not reached until approximately the middle of the book, the first chapters being taken up with the history of early and modern marine propellers arranged in chronological order. This is followed by short chapters on the resistance of ships, slip, cavitation and racing, and then the subject of paddle-wheels is taken up. This is treated with perhaps more thoroughness than is usual in books on marine propulsion, much valuable data being given. A short chapter describes what has been done in the way of developing hydraulic propulsion, and points out the theoretical advantages and disadvantages of this means of propulsion. Coming to the screw propeller itself, we find the subject treated with the author's characteristic thoroughness and clarity. The geometry of the screw propeller, various forms and types of propellers and the materials used in their construction, besides the theory of the screw propeller, are all discussed at length. The last part of the book includes data from the most recent experiments made by Sell, Isherwood and others. Some valuable tables are also included, giving complete data regarding the performance of various steamships on trials.

Steam Power Plant Piping Systems. By William L. Morris, M. E. Size, 6 by 9 inches. Pages, 490. Figures, 389. New York, 1909: McGraw-Hill Company. Price, $5.00 net.

The subject matter of this book is the result of the author's personal experience in the design of piping systems for steam power plants, and the subject is discussed solely from his point of view. This does not mean, however, that the book lacks breadth or completeness, for the author has had a wide and varied experience and is amply qualified to write as an expert

on his subject. In fact, the results of the study and work of a specialist are here presented in such form that the average engineer can profit by them. The design of boilers and engines is not touched upon, but all auxiliary apparatus in the pipe circuit between the boiler and engine and in the various piping systems for steam, oil, air, etc., have been treated and their general design discussed.

The author points out that the chief requisite in pipe work engineering is to so design as to permit repairs of disabled lines without interfering with the regular service of the plant. This he suggests can best be accomplished by allowing the pipe fitters and manufacturers to design the details of the piping, a part of the work which the engineer himself is seldom capable of doing to the best advantage and for which he can rarely afford to employ specialists. It would then devolve upon the piping contractor to design the details, and the responsibility for good pipe design would then be fixed, for the contractor's reputation would depend upon his design as well as upon his workmanship. The engineer could then devote his entire time to getting out complete piping system diagrams, and so designing the complete arrangement as to meet the chief requisite for good pipe work mentioned above, work which he is or should be qualified to do. This method deserves thorough consideration, for it evidently has much to recommend it.

Marine Engineering. By A. N. Somerscales. Size, 5½ by 8½ inches. Pages, 445. Figures, 153. Glasgow, 1909: James Munro & Company, Ltd.; London, Simpkin, Marshall, Hamilton, Kent Company, Ltd. Price, 12/6 net.

The author of this book has had considerable experience in assisting candidates to prepare for the Board of Trade examination for extra first-class engineers, and the information needed for such work forms the basis of the book. While the book is primarily useful for those who desire a hand-book for preparation for the extra examination, yet it covers most of the ground usually included in mechanical and marine engineering, and so forms a valuable book on the general subject of engineering. It is divided into three parts, with an appendix. Part I. contains short essays on physical and engineering subjects; Part II., solutions of questions on mensuration, mechanics, etc.; Part III., the proof of rules and formulæ used in engineering work, while the appendix contains tables and examination papers. While the book is by no means an elementary treatise on the subject, yet it is no more theoretical or complicated than the subject demands. In fact, much of the material is presented in the form of practical questions and answers, the complete solution of the problem being given in detail in each case.

History of New York Shipyards. By John H. Morrison. Size, 6 by 9 inches. Pages, 165. Figures, 22. New York, 1909: William F. Sametz & Company, Price, $2.00.

During the era when wooden sailing ships formed the principal part of the mercantile marine in every country, America had an undoubted supremacy, due to the excellence of her ships and sailors. At this time wooden shipbuilding was in its most prosperous condition, and New York shipyards were turning out some of the fastest and most famous ships afloat. With the advent of iron and steel ships shipbuilding in and about New York rapidly declined, and, although numerous large and important repair yards have been developed to meet the necessities of such a large port, yet shipbuilding, as applied to the construction of new vessels, has never reached the same importance in New York that it formerly occupied in the days of wooden sailing vessels. The story of the development and decline of this industry involves much that is of interest, not only regarding mechanical details and methods of construction, but also regarding labor conditions and the men who carried on these enterprises. These are carefully treated by the author.

One of the most interesting parts of the book is that dealing with clipper ships, in which the records of some of the most prominent clipper ships that sailed from New York from 1841 to 1860 are given. This information has evidently been compiled with the greatest care and accuracy, and it is the only thing of the kind which we have ever seen.

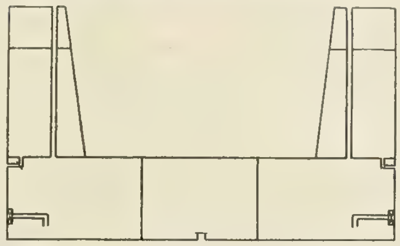
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

916,736. PNEUMATIC FLOATING DOCK. JOSEF LÖFFELHOLZ, OF STERKRADE, GERMANY, ASSIGNOR TO GUTEHOFFNUNGSHÜTTE, AKTIENVEREIN FÜR BERGBAU UND HÜTTENBETRIEB, OF OBERHAUSEN, II, GERMANY.

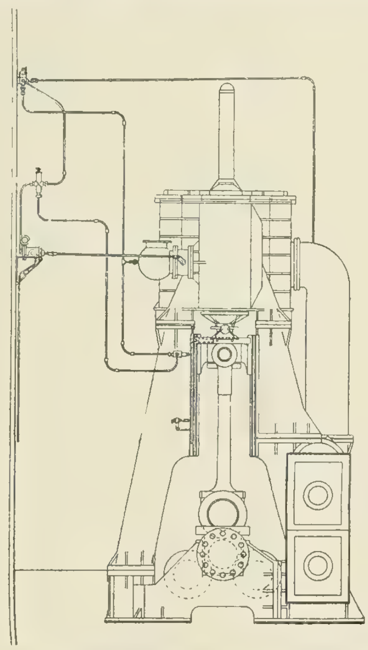
Claim.—A floating dock with independent air compression chambers in the side walls, and in the bottom pontoon, and with means for admitting



water directly into said chambers from the outside to compress the air therein, said chambers having no communication with each other. One claim.

919,713. GOVERNOR FOR MARINE ENGINES. JOHN GORDON, THOMAS JACKSON, AND CHARLES ANDREWS, OF LONDON, ASSIGNORS TO ANDREW'S GOVERNOR PATENTS LIMITED, OF LONDON, A COMPANY OF GREAT BRITAIN AND IRELAND.

Claim 2.—In a speed-governing apparatus for marine engines, a means for controlling the supply of power to the engine, a cylinder for operating said means, a valve for controlling the passage of motive fluid to said cylinder, a gravity-controlled tiltable device, arranged to



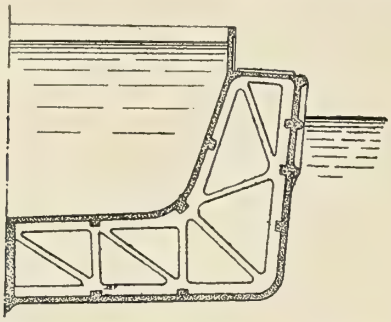
operate said valve, in combination with a momentum governor, and an automatic by-pass valve arranged to admit motive fluid to said cylinder and to cut out from action the valve first named and means operated by the said momentum governor for supplying motive fluid to the by-pass valve to operate the latter. Two claims.

920,285. FLOATING DRYDOCK. WILLIAM THOMAS DONNELLY, OF BROOKLYN, N. Y.

Claim 5.—In a floating drydock, sides, pontoons, compartments in said pontoons each compartment provided with a water inlet and a water outlet, a pump having a combined inlet and outlet into and from the compartment and a combined water inlet and outlet communicating with the water inlet and the water outlet of the compartment and means for preventing water from being discharged from the water inlet of the compartment. Six claims.

920,046. FLOAT OF REINFORCED CONCRETE. CARLO GABELLINI, OF ROME, ITALY, ASSIGNOR TO SOCIETA' CEMENTO ARMATO E RETINATO GABELLINI, OF ROME, ITALY.

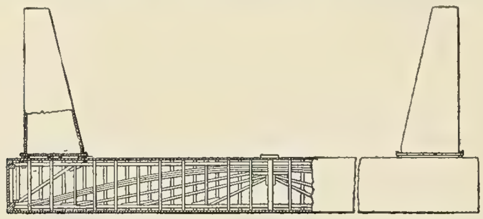
Claim 1.—Floats formed of reinforced concrete provided with hollow



watertight compartments, allowing passage of a person through said compartments. Two claims.

920,282. FLOATING DRYDOCK. WILLIAM THOMAS DONNELLY, OF BROOKLYN, N. Y.

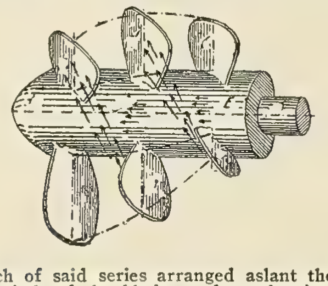
Claim 1.—In a floating drydock, a series of pontoons buoyant when filled with water, sides or wings supported thereon non-buoyant when



filled with water and passages establishing communication between said pontoons and sides or wings, whereby water is admitted to and exhausted from the sides or wings through the pontoons. Three claims.

921,423. SCREW-PROPELLER. GEORGE MACKANESS, OF DRUMMOYNE, SYDNEY, NEW SOUTH WALES, AUSTRALIA, ASSIGNOR OF ONE-HALF TO JOHN BARNES, OF MOSMAN, SYDNEY, ANSTRALIA.

Claim 1.—A propeller comprising an elongated hub, a plurality of series of blades, each series having its blades increasing in length and similarly proportioned up to the limit of their respective length, and



said blades in each of said series arranged aslant the hub in a direction opposite the pitch of the blades and overlapping when viewed in a direction parallel to the axis of the hub. Two claims.

921,641. METHOD OF PREVENTING CORROSION OF METALS IMMERSED IN LIQUIDS. PEREGRINE ELLIOTT GLOUCESTER CUMBERLAND, OF ST. KILDA, VICTORIA, AUSTRALIA.

Claim.—The method of preventing the corrosion and decomposition of propeller shafts and other metallic portions of ships immersed or in contact with sea water and whereby two or more electrically opposed metals are in juxtaposition and connected in parallel and constitute a negative electrode, consisting in placing additional iron means in contact with the water in proximity to the metal parts to be protected and insulating said iron means from said parts except through the sea water, and connecting said metal means in parallel and to the positive pole of an auxiliary source of electrical energy having a higher electromotive force than that caused by the difference of electric potential between the various metals comprised in the structure to be protected, and connecting the negative pole to said source of energy and said metals to be protected constituting the negative electrode. One claim.

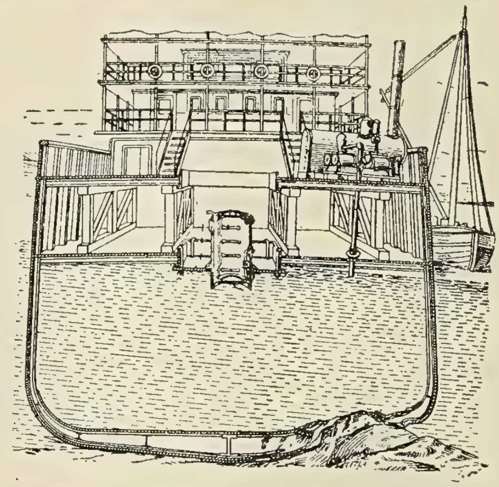
British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 4 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

24,085. TURBINES. H. DAVEY AND H. N. DAVEY, EWELL, SURREY.

Turbines are driven by a mixture of hot air and steam, or by a mixture of combustion products and steam. In one modification, the two fluids do not mix until exhausted from the turbine. Combustion products pass from a combustion chamber upwards through a heater, thereby heating air drawn in by a fan. The combustion products then raise steam in a generator, which passes along a pipe to a turbine wheel, after which it mixes with the hot air passing through the heater. This mixture drives a turbine wheel and exhausts into the combustion chamber thereby furnishing the required oxygen. In a modification, the combustion chamber is surrounded by a generator. The lower part of a turbine wheel is driven by the combustion products, and the upper part by steam from the generator. The flow of steam is controlled by a valve. The mixture exhausts into a condenser, the condensed steam being removed by a suitable pump, and the residual gas being withdrawn by a fan. In a further modification the combustion products, on leaving the combustion chamber, raise steam in a generator. The steam acts upon a turbine wheel and then, mixed with the combustion products, acts upon a turbine. The mixture next passes through a condenser, whence the residual gas is withdrawn by a fan.

24,482. RAISING SUNKEN VESSELS. W. W. WOTHERSPOON AND R. O. KING, NEW YORK, U. S. A.

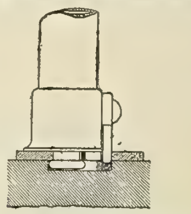
Relates to the method of raising stranded or sunken vessels, in which the ordinary means of communication with the various compartments are made air tight, the decks and walls of the compartments are braced and strengthened to withstand the pressure, airlocks are provided for the ingress and egress of workmen, and compressed air is admitted to expel the water from the compartments. According to the present invention, when the leak is in the side of a compartment, the water is expelled to the top of the hole by the air pressure, and the hole is closed by the progressive downward application of a covering. When



leaks occur in a number of compartments, means are provided for adjusting the air-pressure according to the different hydrostatic pressures encountered, and, in making the hatchways air tight, the hatch cover and gasket are temporarily held against the coaming until the compressed air is admitted. The deck is strengthened by beams or braces or by other means. To render the compartment air tight, a plate or covering is held against the coaming of the hatchway with a rubber gasket packing is interposed. The plate is temporarily held in place before the admission of compressed air by means of vertical stay-bolts. To the coaming of the hatchway is applied an air lock with doors for the entry and exit of workmen. The air is admitted by a pipe from the compressor placed in any suitable position. To adjust the air pressure according to the hydraulic pressure encountered, the air pipes may be provided with reducing valves.

24,901. SHIP'S STANCHIONS. HOSKINS & SEWELL, MIDLAND BRASS WORKS, BORDESLEY, AND C. JOHNSON, BIRMINGHAM.

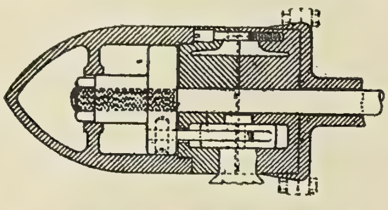
The lower end of the stanchion is provided with a headed stud engaging a keyhole-shaped slot in the base plate. The larger end of the slot is of such a size as to admit the head of the stud. To prevent inadvertent detachment and to keep the stanchion end in place, a loosely



pivoted catch is carried by the stanchion, the lower end of which engages the end of the slot. Clearances are provided to enable the catch to swing clear. Instead of being pivoted, the catch may consist of a loose ring surrounding and sliding upon the stanchion. A downwardly projecting peg is provided to fit the end of the slot.

653. SCREW-PROPELLERS. G. F. VILLINGER, LONDON.

The boss of a reversible propeller is constructed in two main portions and is provided with a covering or cap. The blades have shanks with collars, and an inner journal mounted in bearings formed in the halves of the boss, which is screwed into or bolted to an enlargement on the



propeller shaft. The reversing mechanism comprises a sliding cylindrical block placed in the after part of the propeller on the end of the reversing rod and connected by links to the collars of the blades. Instead of the rods racks engaging with teeth on the collars may be used.

International Marine Engineering

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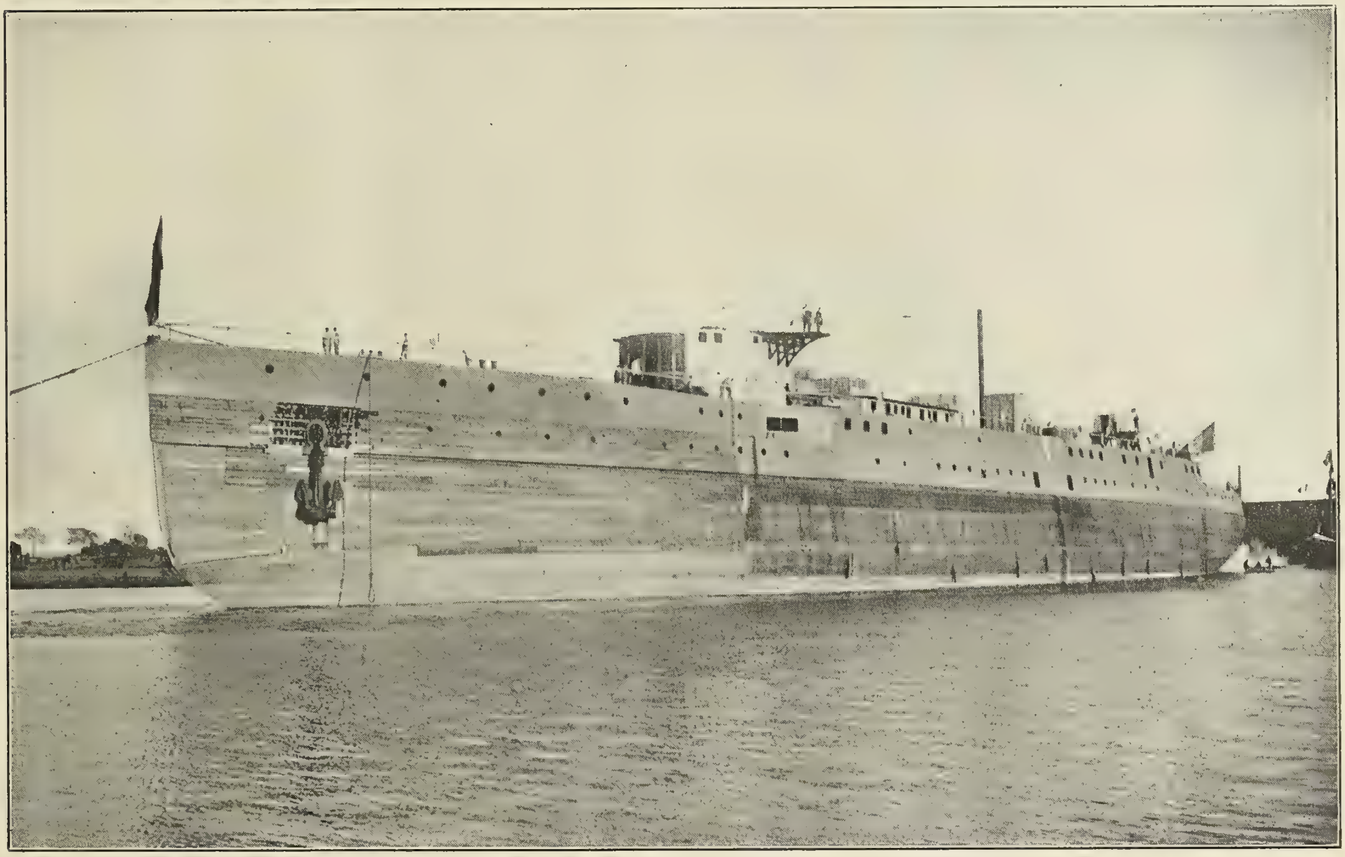
THE FRENCH BATTLESHIPS DIDEROT AND CONDORCET.

The *Diderot* and *Condorcet* are two of the six battleships of the *Danton* class authorized in the French naval programme of 1906-1907. The other ships of this class are the *Voltaire, Vergniaud* and *Mirabeau*. These ships are all of the same general dimensions and arrangement but differ somewhat in details. The first of these to be launched was the *Voltaire*, in January, 1909, at La Seyne, near Toulon. The *Diderot* and *Condorcet* were launched at St. Nazaire, the former on April 19, 1909, from the yards of the Chantiers de L'Atlantique, and the latter, April 20, from the Ateliers & Chantiers de La Loire. The other three ships are still on the ways, the *Verginaud* at the Ateliers de La Gironde, Bordeaux; the *Danton* at Brest, and the *Mirabeau* at Lorient. All, however, will soon be ready for launching.

The principal dimensions of the *Diderot* and *Condorcet* are as follows:

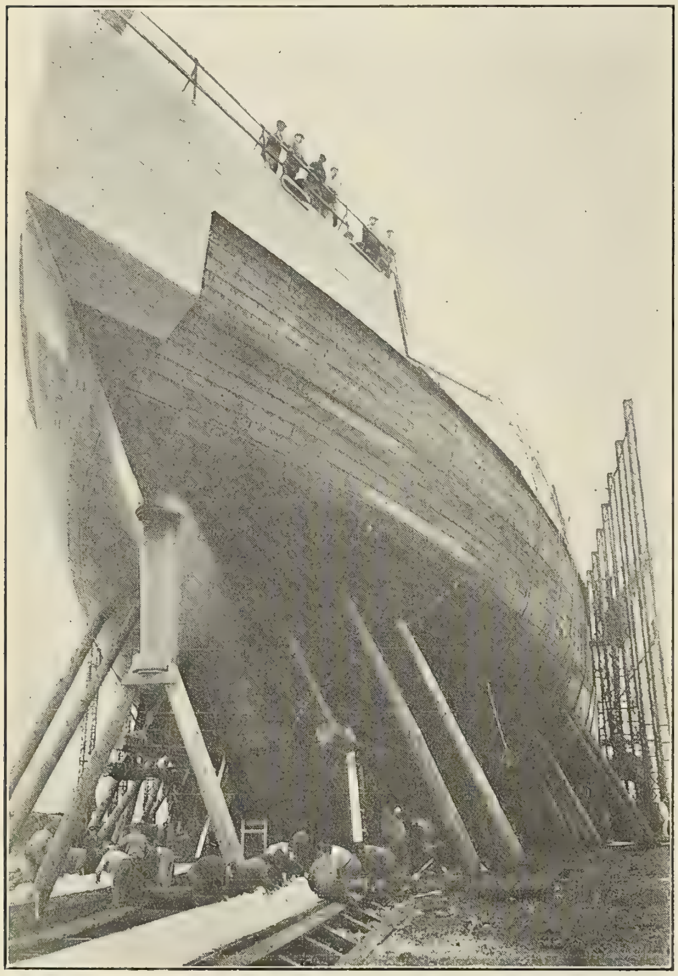
Length over all	481 feet.
Length on waterline	476 feet.
Extreme beam	84 feet 8 inches.
Depth, at full load, amidships	27 feet 1 inch.
Full load displacement	18,235 tons.
Designed horsepower	22,500
Speed	19.25 knots.

These battleships have no metallic keels, simply a false keel and two docking keels of teak. The docking keels, as well as the steel bilge keels, extend for more than half the length of the ship amidships. The stem is of forged steel and the stern of cast steel. There are nine keelsons on each side of the main keel. Amidships, the frames are spaced about 34 inches center to center. The double bottom extends up to the lower protective deck. The outside plating varies from ⅜ to ¾ inch in thickness, or from 15 to 30 pounds weight. Behind the belt of side armor there is a double thickness of ⅜ inch or 15-pound plate. Numerous watertight compartments subdivide the hull from end to end. Many of these are not even pierced by watertight doors.



DIDEROT IN DOCK AFTER LAUNCHING, SHOWING EXTENT OF MAIN ARMOR BELT.

The general protection of the ship is according to the French principle of the "caisson blinde" in connection with a "caisson cellulaire," protecting the ship as far as possible against torpedo attack. At the center line of the ship the lower protective deck is slightly above the load-waterline. At the sides it is 4 feet 10 inches below this, where it is connected with the upper edge of the "caisson cellulaire." An upper protective deck is worked at the height of the upper edge of the belt of side armor; that is, 8 feet above the load-waterline. This deck is constructed of three thicknesses of plate, each ⅝ inch thick. The lower protective deck is constructed of three plates each ⅝ inch thick on the flat, but on



STERN VIEW OF THE DIDEROT ON THE WAYS.

the slopes it is protected in addition by armor plates 4 inches in thickness.

As shown by the photographs, the main armor belt extends from the stem to within a few feet of the stern. It is composed of three strakes. The lower edge of the first strake is 3.15 inches thick amidships and at the sides of the 12-inch turrets, while the upper edge is 10.63 inches thick amidships and 7.87 inches at the sides of the 12-inch turrets. Forward and aft of this the lower edge of the first strake is 2.36 inches thick and the upper edge 7.09 inches thick, while at the ends the lower edge is 2 inches thick and the upper edge 3.15 inches thick.

The second strake is 9.84 inches thick amidships, 9.06 inches thick at the lower edge and 7.87 inches thick at the upper edge at the sides of the 12-inch turret; forward, it is 7.87 inches thick at the lower edge and 6.69 inches thick at the upper edge; while astern it is 5.41 inches thick, and at the ends 3.15 inches thick. The third strake is 2½ inches thick and about 115 feet long, extending from the stem to a point just aft the forward 12-inch turret. The armor belt is placed on a teak backing, which has an average thickness of 3.15 inches. Forward there is an athwartship armored bulkhead, 7.09 inches thick, extending from the sides to the 12-inch center line turret. There is a similar armored bulkhead, 7.8 inches thick, at the after 12-inch turret.

The 12-inch gun turrets are protected with 11.81 inches of steel armor and the barbettes with 11.02 inches of armor. The 9.4-inch guns are protected by 8.66 inches of steel in the turrets and 7.87 inches in the barbettes.

The space between the two protective decks and the armor belt, which is termed the "tranche cellulaire," is divided into numerous small compartments, with a passage at the center line of the ship. These compartments form bunkers and storerooms and give access to a cofferdam, which is worked throughout the entire length of the ship the total height of the armor belt. All passages, funnels, ventilators, etc., extending through the "tranche cellulaire" have been reinforced their entire height.

The "caisson cellulaire," which is designed to protect the ship as far as possible against torpedo attack, is constructed as follows:

About 8 feet 6 inches from the outside plating a vertical longitudinal bulkhead has been worked. This has an average height of 16 feet 6 inches and is made of plates having a total thickness of 1¾ inches. Behind the cofferdam and at a certain distance from it there is a second vertical bulkhead, .59 inch thick, extending from the double bottom plating to the lower protective deck. Forward and aft bunkers and other compartments provide the same protection as these bulkheads. This "caisson cellulaire" form of protection was used for the first time on board the *Czarwitch,* built in 1899 at the Forges & Chantiers de la Mediterrannée, and proved its efficiency by saving the ship from a total loss when under heavy torpedo attack.

Only one conning tower is fitted, and this is located on the navigating bridge, where a clear view can be obtained. It is noticeable that there are no obstructions on the bridge, as there are on all previous battleships or armored cruisers belonging to the French navy. The conning tower is protected by 11.81-inch armor, while the armored tube leading to it is protected by armor 8.66 inches thick above the upper protective deck, and 2.36 inches thick between the upper and lower protective decks.

From the foregoing it is evident that the protection of these ships is very good for an 18,000-ton battleship. Of course, it might have been better, but any additions would have necessitated a greater displacement, which, at the time these ships were designed, was impossible, owing to the condition of financial and political matters.

The main armament consists of four 12-inch guns mounted in pairs in two revolving turrets on the center line of the ship, one forward and one aft. There are twelve 9.4-inch guns, mounted in pairs in six revolving turrets, located on the spar deck. The secondary battery is composed of sixteen 3-inch quick-firing guns and ten 1.8-inch guns. It has been stated that two 18-inch submerged torpedo tubes would be fitted forward, but, up to the time of launching, no special arrangements were made for them, and it is now expected that the space and weight which they would occupy will be used for ammunition for the heavy guns.

The armament of these ships has been widely criticised, but the fact still remains that these boats have been built to fight in the Northern seas, where it is very likely that the future naval supremacy will be settled by the European powers. In these waters foggy weather makes it difficult to fight at a distance much over 3,000 yards. At this distance these vessels

will be able to do effective work with their large quick-firing guns. At the same time such an armament is capable of making a good showing against any of the battleships belonging to the Triple Alliance in the Mediterranean. Of course, it must be admitted that this armament would be at a disadvantage in fine weather against the latest types of English or American battleships. It is practically certain that on future French battleships the *Dreadnought* idea will be carried out by using only big guns of a single caliber for the main battery, but in that case the displacement will be increased at least to 20,500 tons.

Just criticism can very well be made of the secondary battery of the *Diderot* and *Condorcet*. The 3-inch 12-pounder guns are not efficient against modern torpedo-boat destroyers. Four-inch quick-firing guns would at least be fairly efficient and it cannot be readily understood how such a small-caliber gun has been selected for this work. Also, the secondary battery is so arranged that it is practically unprotected, and the chances are that after an engagement this indispensable battery would be out of commission.

The forward and stern fire consists of two 12-inch and eight 9.4-inch guns. The broadside fire consists of four 12-inch and six 9.4-inch guns. The anti-torpedo-boat fire on each side consists of two 3-inch guns forward and four 3-inch guns in two casemates at the center of the ship, and two 3-inch guns aft, besides the 1.8-inch guns, which are located in various commanding positions on the bridge and spar decks.

It is very evident that in these ships the defensive qualities have been much better carried out than the offensive qualities. This of course is strange, since a battleship is built for fighting purposes and it is almost impossible to get the advantage over an enemy which has much heavier offensive powers.

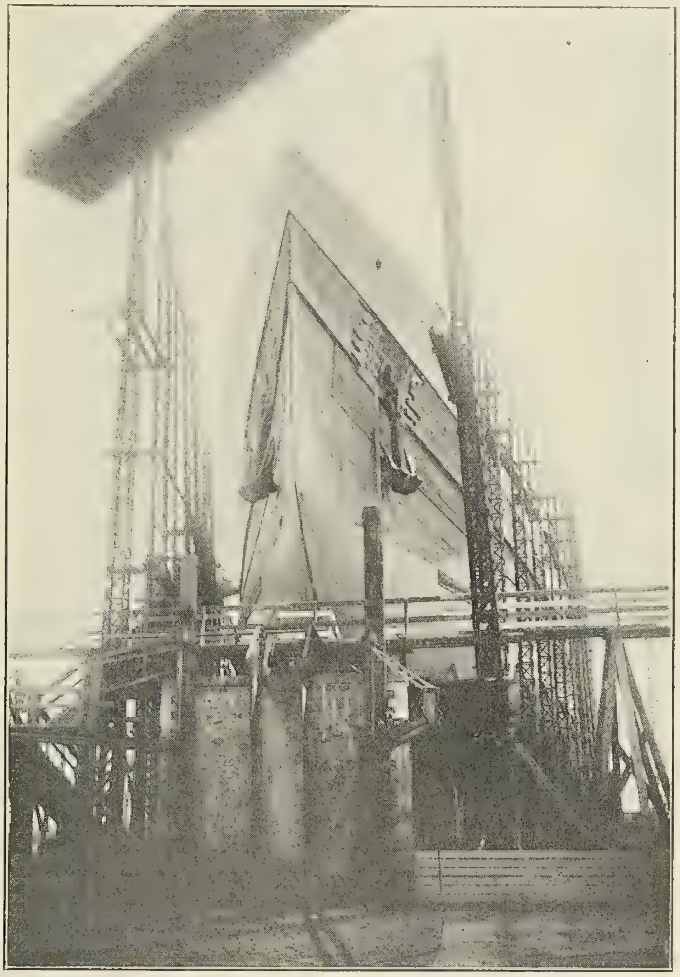
The ships will be propelled by four screws, each driven by Parsons turbine engines. There are eight turbines in each ship, four for full speed forward, two for the lower cruising speeds and two for astern speed. The dimensions of the high-speed turbines are as follows: High-pressure, diameter, 9 feet; length, 23 feet 10 inches. Low-pressure, diameter, 12 feet; length, 23 feet 6 inches. The high-pressure turbines drive the outside propellers, and the low-pressure turbines the inside screws. At full speed, the designed number of revolutions is 300 per minute. The high-pressure cruising turbines are on the inside shafts, the steam being exhausted into the high-pressure high-speed turbines and then into the low-pressure turbines. The cruising turbines are 8 feet 4 inches in diameter and 17 feet 6 inches long. The astern turbines drive the outside propellers and are 9 feet in diameter and 12 feet long. The inner shafts are located 7 feet from the center line of the ship, and the outer ones 21 feet 10 inches from the center line.

The *Diderot* and *Condorcet* will each be fitted with twenty-six Niclausse watertube boilers, each boiler having 1,560 square feet of grate surface and 14,150 square feet of heating surface. The normal steam pressure will be 257 pounds per square inch. During the forced-draft trials the pressure of water in the stokehold must not exceed 1.18 inches of water.

The boiler tubes are 3 5/16 inches outside diameter and the ordinary tubes 3 1/32 inches inside diameter. The reinforced tubes are 2 27/32 inches inside diameter. There are five funnels, 83 feet high above the grates, with maximum diameters of 8 feet 3 inches and minimum diameters of 4 feet 4 inches.

For the trials of these battleships the allowable coal consumption is calculated per mile and not per indicated horsepower hour. The contract figures were as follows: For the 10-hour full-speed trial, all boilers to be worked with forced draft, coal consumption per mile run, 2,060 pounds; per square meter of grate area, 287 pounds. For the 6-hour full-speed trial, with three-quarter boiler power and forced draft, the consumption per mile run is not stipulated, but the consumption per square meter of grate area is 397 pounds. For the 24-hour ordinary trial, with full boiler power at natural draft, the coal consumption is to be from 1,410 to 1,500 pounds per mile run and 183 pounds per square meter grate area. At low speed (10 knots), the consumption is to be from 573 to 618 pounds of coal per mile run. The total bunker capacity of each ship is 2,100 tons, and the approximate steaming radius at 10 knots speed, 8,130 miles.

The ships are lighted throughout by electricity and heated by steam. Only those auxiliaries requiring a large amount of power are driven by steam, all others are driven by electricity.



BOW VIEW OF THE CONDORCET JUST BEFORE LAUNCHING.

The dynamos are driven by turbine engines. Eight searchlights are to be fitted, two forward, two in the masts, two amidships and two aft.

The estimated cost of each of these ships is as follows:

Hull and machinery	$8,331,500	(£1,712,500)
Armament	1,939,566	(398,000)
Miscellaneous	35,967	(7,380)
Total	$10,307,033	(£2,117,880)

National Motor Boat Show

The 1910 National Motor Boat Show is to open at Madison Square Garden, New York City, at noon Feb. 19, and continue until Feb. 26. It has been decided to open the doors to the public every morning at 9 A. M., so as to afford business men and out-of-town parties an opportunity to visit the show at a time most convenient to them.

SUPERHEATED STEAM IN MARINE WORK—III.

BY F. J. ROWAN.

STEAMERS FITTED WITH SUPERHEATERS AND RESULTS.

It is no bad evidence of the practical success of superheating steam to find that there are now afloat about 220 vessels of all sizes, from canal boats up to naval cruisers, which are equipped with superheaters. Of these Germany has the credit of having equipped 165 steamers (about 130 for the canals, lakes and rivers of the continent of Europe and for coasting service, some thirty sea-going steamers and four or five vessels of the Imperial navy); Britain about forty (all deep-sea steamers, including four cruisers of H. M. navy); America twenty (of which eight are naval vessels), and France six or seven (all merchant vessels). There may be some others, as it is not an easy matter to ascertain what is being done in such a matter, but we believe that our information is practically complete.

Taking the countries in the order named, it is to be observed that the steamers ascribed to Germany include the vessels belonging to that country and those owned in Switzerland, Italy, Austria-Hungary, Russia, Sweden and Holland, many of them having been fitted by engineers in those countries. They are, however, all fitted with one or the other of the various forms of the Schmidt superheaters (with one or two exceptions), and are worked on Herr Schmidt's system of high superheat. The first marine boilers fitted with these superheaters were built in 1898 by Messrs. Sulzer Bros., of Winterthur, and were supplied to steamboats plying on some of the lakes in Switzerland. The cost of coal being comparatively high in that country, the economy of fuel, due to the superheating, was a matter of great interest to the owners of such craft. Good results having been obtained from the Swiss lake steamers, the equipment of those running on the North Italian lakes, the Lake of Constance and on the rivers Oder, Danube, Volga, etc., soon followed. The horsepower of these lake steamers ranges from 100 up to 1,000, the majority being 300, 400 and 600 horsepower. The river steamers have from 130 to 800 horsepower, and following these came the larger Rhine steamers of 1,000 to 1,350 horsepower, with which "results of an extremely satisfactory nature were achieved."

Among the sea-going vessels fitted are the vessels of the Oldenbourg-Portugal Steamship Company, of Oldenbourg, and the Argo Steamship Company, of Bremen; these steamers having engines of 900 and 950 horsepower. The war ships include the cruisers *Dresden*, *Ersatz-Jagd* and *Ersatz-Schwalbe*, of 15,000 horsepower each, and the *Ulan*, a steam tender of 1,700 horsepower.

The total horsepower afloat working on the Schmidt system amounts to over 100,000, the superheaters being in nearly every case applied to the standard Scotch or cylindrical type of boiler. About forty of these boilers have the smoke-tube form (Fig. 16), and about ninety have the flame-tube form (Fig. 15); ten having smoke-box or funnel arrangements and three directly-fired superheaters and other special designs.

Regarding results, it is said that superheated steam of a temperature of about 660 degrees F. in compound marine engines gives a fuel economy of approximately 30 percent, as compared with the same type of engines using saturated steam, and about 15 percent as compared with triple-expansion engines also using saturated steam. Accurate records of the working of the Rhine steamers *F. Haniel I.* (of 1,000 horsepower) and *Hugo Stinnes I.* and *II.* (each of 1,350 horsepower), which have been running since 1905, with compound engines and superheated steam on this system, bear out the claim of economy. It has been found that in paddle steamers there is considerable loss of heat in the steam from the boiler, on account of the comparatively small number of revolutions per minute made by the engine. Consequently, with saturated steam the loss from condensation is greater than with stationary engines. Thus with superheated steam the saving in fuel (which is less than the saving in steam) is greater in paddle boats than with stationary engines of the same power, and amounts to about 30 percent with a superheat of 270 degrees F. On screw steamers the fuel economy amounts to about 25 percent for the same degree of superheat.

In the case of twelve steamers belonging to the two steamship companies mentioned above, which have triple-expansion engines and Schmidt smoke-tube superheaters fitted in their existing boilers, they have realized in continued service an economy of 18 to 20 percent in coal as compared with a saturated steam plant of the same size. The steam pressure in these ships is 185 pounds per square inch, and the average temperature of the superheated steam is 608-644 degrees F. The original piston valves on the high-pressure cylinders were retained and work satisfactorily. In the case of engines having slide valves, however, it is found that a superheated steam temperature not exceeding 518 degrees F. must be used. Efficient lubrication is of great importance in both arrangements, and the method adopted is that of forcing the oil by a pump for the slide valves, or by a lubricator, which forces it into the center of the main steam pipe for the piston valves. These steamships indicate on the average 1,000 horsepower; have a boiler-heating surface of 3,220 to 3,440 square feet, and a superheating surface of 1,180 to 1,290 square feet. Where forced draft on Howden's system is used average economies of 25 to 30 percent in coal have been realized.

In Britain, the first superheating installation made by the Central Marine Engine Works, of West Hartlepool, was in the year 1891. This apparatus, then designated a "steam drier," was fitted on board the steamship *Elmeto*, owned by the London & Northern Steamship Company, and consisted of a series of oblong, cast iron hollow bulbs, bolted together and communicating with one another—these occupying the whole space of the smoke-box immediately above the top row of boiler tubes. The steam passed through the interior of these bulbs, the heated waste gases escaping from the boiler tubes coming in contact with their exterior surface, and this apparatus, though of a simple character, was sufficient to demonstrate that economy could be secured by using partly dried steam, and that the waste gases from boilers could be beneficially used for this purpose.

A few years afterwards the same engineering works fitted in the steamship *Inchmona* a complete set of apparatus designed for superheated steam, including boilers for a pressure of 255 pounds per square inch, superheaters (Fig. 9), Ellis & Eaves' system of induced draft and quadruple-expansion engines on five cranks. The results obtained were sufficiently encouraging to induce the owners to fit up succeeding steamers with the same system, the *Inchdune*, *Inchmarlo* and *Nassovia* being the first of the fleet, which also includes the *Inchkeith*, *Incharan* and *Inchmore*. The two first named were placed in commission in 1900, and were succeeded by the other vessels. "These are fine freight vessels of 6,000 tons, fitted with quadruple-expansion, five-crank engines, one high-pressure, two intermediate and two low-pressure cylinders; air, bilge and feed pumps being driven off the main engines. The working pressure at the boiler is 267 pounds per square inch, and the waved-tube superheaters are set in the up-takes, just above the upper row of tubes of the two Scotch boilers, each of which is 13 feet in diameter by 10 feet 6 inches long. The steam is superheated from 412 degrees F. (the temperature due to the pressure) to 469.5 degrees, or a superheat of 57½ degrees F. The temperature maintained in the second receiver and at the high-pressure steam chest averaged 447 degrees. The waste gases, in addition, heat the air for combustion in the furnace about 250 degrees F., or from an out-

side temperature of 54 degrees to 299 degrees F., the draft being controlled by the Ellis & Eaves' apparatus. The waste gases below the superheater have been found to be at 620 degrees, reduced by the superheater to 543 degrees and by the air heater to 404 degrees F., this temperature of chimney discharge showing over 33 percent of the waste heat turned into useful work."

On a trial of the *Inchdune* and *Inchmona*, between West Hartlepool and Dover, the coal consumption is reported to have been only 0.97 pound per indicated horsepower-hour, and the *Inchdune* and *Inchmarlo* have been able to complete their voyages on an average consumption of 1 pound of coal per indicated horsepower-hour. The *Inchkeith* has for her twelve months' consumption in voyages between New York and Bombay an average rate of 1.1 pounds per indicated horsepower per hour. The total degree of superheat imparted to the steam was in the later cases 70 degrees F., making the temperature at the high-pressure steam chest 460 degrees F., and no ill effects have been noticed in the working of the engines, due to this temperature. It was stated by Mr. W. Bloor that "the diagrams showed an area of 89.7 percent of the area between highest and lowest pressure, and that comparative diagrams with saturated steam showed superiority in area of the superheated vapors as high as 15 percent.

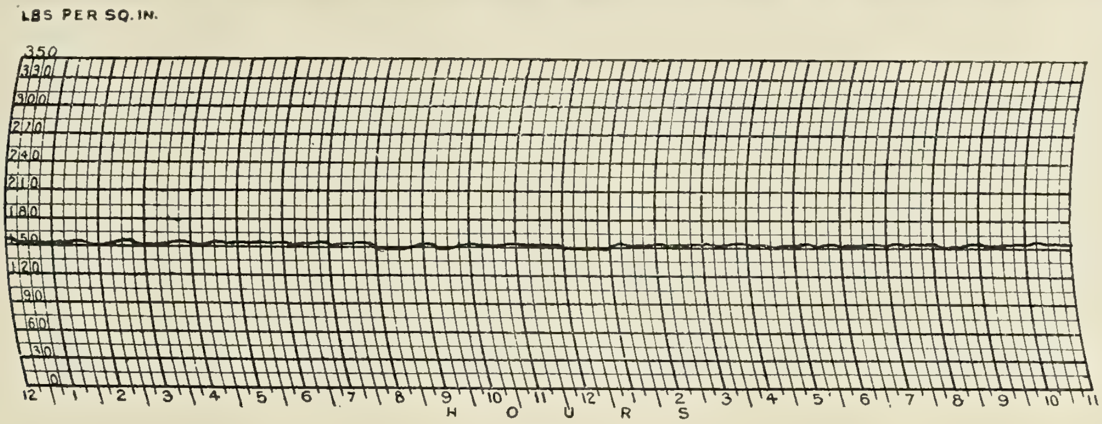


FIG. 20.

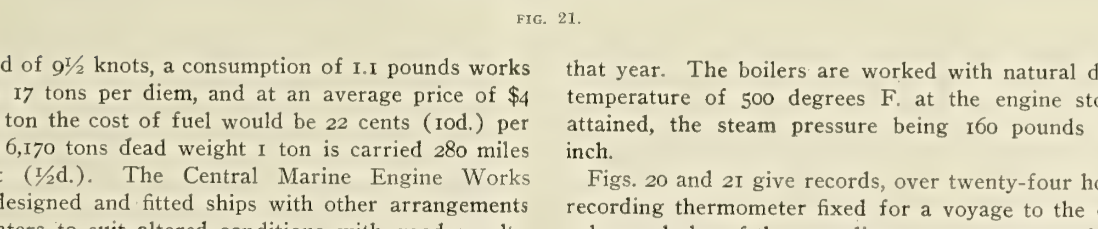


FIG. 21.

At a speed of 9½ knots, a consumption of 1.1 pounds works out to only 17 tons per diem, and at an average price of $4 (16/8) per ton the cost of fuel would be 22 cents (10d.) per mile, or at 6,170 tons dead weight 1 ton is carried 280 miles for a cent (½d.). The Central Marine Engine Works have also designed and fitted ships with other arrangements of superheaters to suit altered conditions with good results One of these vessels had about 3,000 horsepower with four-crank, quadruple-expansion engines, Howden's forced draft arrangements and superheaters, but was, unfortunately, sunk in collision with an iceberg at an early period of her career.

Mr. W. S. Hide is one of the pioneers in this field, having commenced to introduce superheaters into the vessels of Messrs. Thos. Wilson, Sons & Company, Ltd., at a comparatively early date. The first steamer so fitted was the *Claro*, of 5,350 tons displacement, and from 9 to 9½ knots speed, and her first voyage was made in November, 1900. That vessel was fitted with forced draft, a superheater in the funnel, and an air heater. The funnel gases were discharged at a temperature of about 420 degrees F., the temperature of the steam being from 490 degrees to 520 degrees F. at the engine stop valve, the temperature depending to some extent on the quality of the coal. The machinery has run, with the exception of some few initial troubles, without any bother whatever. The troubles at the commencement were due entirely to ignorance of the requirements imposed by the dryness of the steam at the above temperature; but having overcome these, no more trouble has been experienced than with ordinary machinery. The steam pressure was nominally 200 pounds per square inch, the engineer usually working with about 195 pounds on the boiler and 190 pounds on the engine, the superheat being thus about 120 degrees F. average in the high-pressure cylinder. The vessel having given very satisfactory results, it was decided to fit a superheater in the *Colorado*, a vessel of 8,400 tons displacement and 11½ knots speed, employed in the Atlantic trade. This was done in 1902, and the vessel has been running with the superheater since March of that year. The boilers are worked with natural draft, and a temperature of 500 degrees F. at the engine stop valve is attained, the steam pressure being 160 pounds per square inch.

Figs. 20 and 21 give records, over twenty-four hours, of the recording thermometer fixed for a voyage to the engine stop valve, and also of the recording pressure gage, and these show how steady both steam pressure and temperature are kept in practical working, with fires cleaned in the usual course.

The *Aleppo*, a vessel engaged in the Indian trade, of 8,600 tons displacement and 9 knots speed, was next fitted, giving similar results to the above, the boilers being worked with natural draft. The *Martello*, a vessel similar to the *Colorado*,

fitted with watertube boilers of the Babcock & Wilcox type, under natural draft, had a superheater in the funnel, her steam pressure being 210 pounds. The *Idaho,* a vessel of 11,100 tons displacement and 11½ knots speed, with engines of the quadruple-expansion type, working at a pressure of 215 pounds per square inch, and boilers with forced draft, has a superheater and an air heater. Her steam temperature at the engine stop valve is from 510 degrees to 520 degrees F., and the funnel temperature from 350 degrees to 360 degrees F., and the consumption of coal is quite satisfactory.

No deterioration has been observed in the superheater tubes of the *Claro* after upwards of five years' running. Altogether, there are now fifteen vessels of this fleet fitted with superheaters, all of which are working satisfactorily. The superheater is placed at the base of the funnel, and thus utilizes the waste heat of the escaping gases. The steam temperature at the engine stop valve ranges from 500 degrees to 600 degrees F. in the various ships. No noticeable advantage has been found by working at a higher temperature, but there is a distinct loss directly the temperature falls much below 500 degrees F. By taking the temperature of the steam in an intermediate valve chest, Mr. Hide found that it takes from 80 to 100 degrees of superheat to do the work in the high-pressure cylinder, any superheat above that amount appearing in the intermediate-pressure valve chest. A superheat of less than 80 degrees has not been found to be of any practical value or to show any decided economy; above that degree a gain of 12 to 16 percent may be counted upon, depending on the various contributing factors, such as type and design of engine, amount of superheat, pressure of steam, etc. Difficulties are occasionally experienced with piston rings and glands in marine engines, which are absent from practice on land; and Mr. Hide accounts for this by the fact that the land engine is always maintained steady in a vertical position, whereas, this is not always so on board ship. The difference in the running of the engines with superheated and with saturated steam is very marked; directly the superheated steam is turned on all leakages of water at the glands are stopped, and the engine runs quite dry. The oil used for lubrication is a specially pure hydrocarbon oil, having a flash point of about 700 degrees F., and is quite satisfactory; the amount used in an engine of about 1,800 indicated horsepower being about 2 quarts per twenty-four hours, including the swabbing of all rods.

One of the Wilson fleet is the steamer *Martello,* which is fitted with Babcock-Wilcox boilers; and although fitted with four boilers she is able to maintain full speed on her voyages with three boilers, having 8,055 square feet of heating surface and a superheater surface of 2,000 square feet, the degree of superheat being 90 degrees F. Generally, in the working of these vessels the coal consumption per day, or per voyage, is found to compare very favorably with that of other similar ships.

Some of the steamers of the Great Eastern Railway Company's fleet were fitted some years ago with Watkinson superheaters (Figs. 11, 12). Of these, the twin-screw steamship *Yarmouth* was built by Messrs. Gourlay Bros. & Company, Dundee; the steamships *Clacton* and *Amsterdam* by Messrs. Earle's Shipbuilding Company, Ltd., Hull; the superheaters being made by Messrs. Mechan & Sons, Ltd., Glasgow. Beyond the fact that on trial a saving of about 18 percent was realized in fuel as compared with a sister ship with saturated steam, there are no data available about the performance of these vessels. The Allan Line steamship *Mongolian* was fitted with a Watkinson superheater of the independently-fired type, and although it worked well the engines gave trouble by frequent breaking of the piston rings. This was afterwards found to be due to friction caused by a deposit from the decomposition of the oil by heat.

H. M. S. *Britannia* is a first-class battleship of 18,000 indicated horsepower, having eighteen Babcock-Wilcox boilers, with a total heating surface of 40,020 square feet and a total grate area of 1,250 square feet; and three cylindrical boilers, with a total heating surface of 8,100 square feet and grate area of 247 square feet. Six of the Babcock-Wilcox boilers are fitted with Babcock-Wilcox superheaters (Fig. 14), the tube-heating surface of these six boilers being reduced by the amount of superheating surface. The following table gives the results of the official trials. To compare with the thirty hours' trial of six boilers with superheaters, a run of the same duration was made without superheaters, the engine and other conditions of working remaining the same; and in this trial the advantage with superheated steam was a gain of 15 percent.

RESULTS OF OFFICIAL TRIALS.

	Low Power.	Maximum Continuous.	Full Power.
Date of trial	July 9 & 10, 1906	July 14 & 15, 1906	July 17, 1906
Duration of trial	30 hours.	30 hours.	8 hours.
Number of boilers in use	6 B. & W. with superheaters	18 B. & W. & 3 cylindrical.	18 B. & W. & 3 cylindrical.
Heating surface (incl. superh.), sq. ft.	13,308	48,120	48,120
Grate area, square feet	413.4	1,497	1,497
Fuel, kind used	Welsh coal	Welsh coal.	Welsh coal.
Steam, average gage press., lbs.p.sq.in.	200	199	198
Draft, ins. water pressure in stokehold	.57	.325	.87
Indicated horsepower	3,410	13,078	18,624
I. H. P. per square foot of grate	8.25	8.73	12.44
Coal, total consumed per hour, lbs	6,036	19,617	34,082
Coal per I. H. P. per hour, lbs	1.77	1.50	1.83
Coal per sq. ft. firebox surface per h. lbs	14.60	13.10	22.76
Heating surface per I. H. P.	3.90	3.68	2.58
Revolutions per minute	73.7	113.5	127.3
Uptake temperatures	347°F.	348°F.	423°F.
Steam temperature at boilers	200°F.	199.4°F.	198°F.
Degrees Fah. superheat at boilers	92.5°F.	72°F.	87.5°F.
Degrees Fah. superheat at engines	83°F.	33°F.	31°F
Feed temperature	65.6°F	80°F.	103°F
Total water per I. H. P., lbs	18.19	16.21	18.55
Water per lb., coal, lbs	10.276	10.8	10 136
Water per sq. ft. heating surface, lbs.	5.17	4.5	7.37

H. M. S. *Medusa,* a small cruiser, was fitted with eight Dürr boilers, having superheater tubes for trials at the instance of the committee on naval boilers in 1904. The total area of surface in the generating tubes was 21,369 square feet, and that of the superheater tubes was only 1,119 square feet, the tubes having an external diameter of 2¾ inches. So small a superheater could act practically only as a steam drier, but fairly good results were obtained on trial, and H. M. S. *Roxburgh* was fitted out with the same boilers and superheaters (Fig. 13), some details being improved. Seventeen boilers, with a collective heating surface of 41,600 square feet; a superheating surface of 2,245 square feet; a grate area of 1,085 square feet, and a working pressure of 220 pounds per square inch, supply steam for 16,000 indicated horsepower. No comparative results or trials with these boilers are published, but when they were tested on shore they were found to give extremely dry steam.

It is expected that H. M. S. *Bristol,* which is being fitted with Curtis turbines, will also have superheated steam, as that type of turbine is favorably affected by steam of that quality.

In America, the first trials with modern superheaters in marine practice were carried out in the steamer *J. G. Wallace,* fitted with Babcock-Wilcox boilers of 5,800 square feet of heating surface and 830 square feet of superheating surface. The superheaters were placed in the first pass of the hot gases, but were arranged so that they might be cut out of circuit by an alteration of the baffling, and thus the same boilers could be used for trial in the same ship with and without superheaters. The result was that an increased coal consumption of 16½ percent appeared to be due to the use of saturated steam.

Two sister ships of the *J. G. Wallace* were fitted with superheaters, and also following these trials the American navy department fitted superheaters to four of the eight boilers of the *Indiana*. The results of her trials have not been published; but they must have been favorable, from the fact that other warships were subsequently ordered to be fitted with superheaters. In naval vessels the combination of marine turbines with superheated steam is a matter of great engineering interest.

The Southern Pacific Railroad Company's twin-screw steamer *Creole* was fitted with Curtis turbines and ten Babcock-Wilcox boilers with superheaters, using natural draft. The heating surface in the ten boilers is 28,500 square feet, superheater surface 4,350 square feet, grate surface 770 square feet, and the working steam pressure is 250 pounds per square inch. The turbines are of 8,000 horsepower aggregate. The thermodynamic efficiency (according to *Brassey's Naval Annual*, 1908), with steam 250 pounds pressure, works out at 44 percent at 250 revolutions per minute, whereas the *Dreadnought*, with Parsons turbines, showed a thermodynamic efficiency of 50 percent at about 250 revolutions per minute and 61.5 percent at about 330 revolutions. The *Creole's* steam consumption was fully 16 pounds per equivalent indicated horsepower per hour, with steam superheated 74.5 degrees F. It is said that some trouble was experienced with the turbines in later working; and as this was the first example of the application of Curtis turbines to marine work, that is not to be wondered at, if it is a true report.

The United States Navy Department made comparative tests on one of the lake steamers equipped with quadruple-expansion engines, and found that a net coal saving of 14.8 percent was effected by superheating the steam about 80 degrees F. This and previous experience with superheating induced the Mallory Steamship Company to equip their twin-screw steamer *Brazos* with Foster superheaters (Fig. 19). This vessel has quadruple-expansion, four-crank engines of 7,000 horsepower, and eight single-ended Scotch boilers, 14 feet diameter and 11 feet 9 inches long, with 18,000 square feet of heating surface, and a total grate surface of 472 square feet. One Foster superheater serves for each group of four boilers, the total superheating surface being about 4,000 square feet. They were each designed to add 65 degrees F. superheat to 45,000 pounds of steam at 215 pounds pressure per square inch, giving the steam a final temperature of 460 degrees F. The boilers are equipped with the Howden arrangements for forced draft, and the temperature of the gases passing from the superheaters to the air heaters is from 650 to 700 degrees F. The consumption of coal as fired has not exceeded 1.25 pounds per indicated horsepower-hour, and a speed of 14.5 knots has been maintained on 67 tons of coal per twenty-four-hour day.

In France, the Compagnie Générale Transatlantique fitted their steamer *La Rance*, in 1906, with vertical, triple-expansion engines, having Lentz valve gear with poppet valves, cylindrical boilers and Pielock superheaters (Fig. 18). The total heating surface of the boilers was 3,767.5 square feet, and the superheating surface 785.8 square feet. The steam pressure was 177 pounds per square inch and the temperature 518 degrees F., or about 140 degrees F. of superheat. Comparing *La Rance* with a sister ship, the *Garonne*, with similar engine, but with slide valves, and with similar boilers, without superheaters, trials showed the advantages due to superheat to be an increase in power of 18.1 percent and a decrease in coal consumption of 20.1 percent in favor of *La Rance*. Following these good results the same company introduced the Pielock superheater into the steamships *Perou*, the *Caroline* and the *Honduras*, and others are likely to follow. The *Perou* has been also compared in running with a sister ship, the *Guadeloupe*, identical but for superheaters and valve gear, and has shown a gain of 0.35 knot in favor of the *Perou*. Continuous diagrams of steam temperature showed that with superheaters the temperature variations do not exceed 36 degrees F. from the time of starting the engines to that of running at full power, including the period of cleaning fires.

The conditions of the successful employment of superheaters in marine practice may now be said to have been well established, and we may expect in the future a considerable development of the practice, especially in conjunction with turbines, as it is claimed that the steam consumption of the turbine may be reduced 1 percent for each 10 degrees F. of superheat.

REMODELING GASOLINE (PETROL) ENGINES FOR PRODUCER GAS.*

BY H. F. SMITH.

Among manufacturers of internal combustion engines who have, up to the present time, been confining themselves largely to gasoline (petrol), there is a strong temptation to enter the producer gas field, not by redesigning an entirely new engine but by undertaking to adapt the existing design to the requirements of producer-gas work. In many instances this can be done with a fair degree of success, but the degree of success obtained will depend entirely on how well the essential conditions of design requisite for operation on producer gas can be embodied in the existing structure.

There has been in the past an unfortunate impression among builders of this class of engines that about all that is required to make a gasoline (petrol) engine successful for producer gas is to increase the compression to about 150 pounds per square inch. As a matter of fact this is perhaps one of the least important of the several requirements for successful operation on producer gas. There is no reason why compression with producer gas is a matter of any greater importance than it is with gasoline (petrol). A gasoline (petrol) engine, operating under an initial compression of 80 pounds per square inch, will give a higher efficiency than one operating under an initial compression of 30 pounds per square inch. The same may be said of engines for producer gas with exactly the same force, except that with producer gas it is practical on account of the characteristics of the fuel to carry the compression to points that cannot be tolerated for gasoline (petrol). Experience has shown, however, that under ordinary conditions the heat losses introduced by abnormally high compression, together with the increased friction and strain on the various parts of the engine soon become greater than the increased efficiency of the cycle, and there is, therefore, very little gain, and, in some cases, a positive loss, by carrying compression above comparatively moderate limits. No further consideration need be given this point than to note that 150 pounds per square inch gage is perhaps more ordinarily used than any other pressure for producer gas.

Briefly, the main points to be considered in an engine designed for producer gas are: First, the size and location of the inlet and exhaust valves and passages; second, the contour and dimensions of the clearance space; third, the provision of an ample and effective ignition gear. If these three major elements of design are in line with the best practice, the question of compression can be very safely left to take care of itself. If, on the other hand, it is impossible or inconvenient with the existing design of parts to secure ample valve area, properly shaped clearances, and a thoroughly good ignition, it is perfectly safe to assume that no amount of compression

* Abstract of a paper on Gas Engine Construction for Producer Gas Use, read before the National Gas and Gasoline (Petrol) Engine Trades Association, June, 1909.

will make the engine satisfactory for operation on producer gas.

The matter of valves, both as to their location and area, is of great importance. The velocity of gas travel through the ports, both for inlet and exhaust gases, should never be permitted to exceed approximately 80 feet per second. A much lower figure than this will give more satisfactory results. If we assume the customary piston speed of 700 feet per minute we might arbitrarily establish the clear internal diameters of the inlet and exhaust valves at approximately .45 times the cylinder diameter. The cages and passageways leading to the valves proper should also be of extremely ample dimensions, particularly the exhaust passages. Not only should the piping and connections be of ample area, but they should also be provided with very easy curves, and all sharp turns or angles in the exhaust manifold connection should be studiously avoided.

The location of the valves necessarily varies with the type of engine. In general, however, the location of the valves has a very notable effect on the shape of the clearance or combustion chamber; for the highest efficiency the clearance or compression space in the end of the cylinder should have a minimum of exposed heat-absorbing surface in proportion to the volume of the charge. This means that the valve should by all means open directly into the combustion space, and that all pockets or any other notable irregularities of the contour of the combustion chamber should be discountenanced. Engines for use on producer gas must never have any small communicating openings that do not close up flush with the internal surface of the combustion space. Relief cocks and air-starter connections, as well as taps for indicator connections, priming cocks, etc., must all be fitted with plugs or valves closing down flush with the internal surface of the combustion space. Failure to give careful attention to this feature will invariably result in very annoying prematures and back firing.

The question of ignition cannot be given too careful attention. Not only should the mechanism be perfectly reliable, but the source of current must be such as to give a very unusually heavy and hot spark. Ignition devices suitable for use on gasoline (petrol) are frequently entirely unsuited to producer gas. Electric ignition should, of course, be utilized exclusively, and the writer is personally very much inclined to favor a thoroughly substantial form of make-and-break igniter, either mechanically or electrically operated. Electrically-operated igniters of this kind should be supplied from a current source giving not less than 40 E. M. F., and capable of supplying from 2 to 5 amperes of current. For mechanically-operated make-and-break igniters a smaller current supply will suffice. Ordinarily, a storage battery of 10 to 12 volts E. M. F., and a fairly low internal resistance, will give entirely satisfactory results. Dry batteries and primary batteries of any ordinary type are not well adapted to this service, and storage batteries for ignition purposes, together with small dynamos for charging same, are worked out to a degree of perfection that makes the use of any other form of ignition a needless experiment.

The best results are secured when the point of ignition is located very close to the geometric center of the compressed charge. On cylinders over 12 or 14 inches in diameter the question of multiple ignition is worthy of careful consideration.

Coming to the matter of speed regulation, producer gas lends itself to several different methods of governing, but it is by all means best to adopt some form of throttling governing by which an impulse is secured on each regular stroke. Probably the best method is that which involves the throttling of the quantity of the discharge with constant quality of mixture by limiting the lift of the gas inlet valve. Governing by varying the quality of explosive mixture with constant compression can also be worked out in a very satisfactory way for producer gas. The success of this method is due largely to the extremely wide variations of mixture which are explosive when producer gas is used as a fuel. This method has not been used as much as the former method, but the writer sees no reason why it should not be equally successful.

One point in connection with engine design which usually receives very little, if any, consideration on the part of the average builder is the question of the proper control between the proportion of air and gas where the method of governing by constant quality of mixture is employed. It is of the greatest possible importance, particularly in multiple-cylinder engines, that the quality of the mixture in each of the several cylinders be controlled at one point and that by the single movement of one lever or valve. Furthermore, it is very important that this lever, or valve, should have attached to it an indicating device, showing at a glance the amount of air opening for any given position, since under normal conditions it is customary to run suction producer plants with the gas valve wide open, and control the mixture by closing down to a greater or less extent on the air pipe.

Another question comes up in connection with the remodeling of existing designs that is in some particulars deceptive and apt to lead to disaster. We refer to the strength of the various parts of the gas engine. A producer-gas engine of given cylinder bore and given stroke will develop anywhere from 20 to 30 percent less power than a gasoline (petrol) engine of the same dimensions. It is quite natural, therefore, to assume that the stresses on the various parts when operating on producer gas will not be so severe as when operating on gasoline (petrol). The manufacturer, however, must not lose sight of the fact that the higher compression ordinarily employed with producer gas involves at the same time higher initial explosion pressures, and consequently greater strain on the various parts, than where gasoline (petrol) is used as fuel, even though the mean effective pressure and the consequent power is less. It is, therefore, ordinarily not sufficient to take a gasoline (petrol) engine of given cylinder dimensions and correct only the valve areas, clearance, compression and ignition, to make it suitable for producer-gas work. It is usually necessary at the same time to materially increase the strength of all working parts. These remarks, of course, apply particularly to small engines that are not ordinarily subjected to careful analysis as regards the stresses on the various elements. Larger engines are usually checked over with great care, and remarks of this character as to the strength of the various parts of the mechanism would be entirely out of place.

There is not space within the limits of a brief discussion of this kind to take up in detail all of the various features of design that contribute to success in producer-gas work. We can only casually mention the various questions that can be raised in regard to such matters; for example, the cooling of the various parts of the engine. There is room for a great deal of discussion on the question of water-cooled valves and cages and water-cooled pistons. Effective jacketing is at all times a matter of importance, but thorough cooling of every portion of the engine is of double importance where high compressions are employed, as is the case with all producer-gas work.

The question of ignition control is another matter that involves a great deal of possible discussion on both sides. It is, of course, always essential to provide means by which the time of ignition can be advanced and retarded while the engine is in operation, and it is preferable that the exact point of ignition be indicated by the position of the mechanism. There is also a strong tendency on the part of many builders to advance and retard the spark for different loads, to compensate in part for the variation in flame propagation, due to change either in quality or degree of compression of the mixture.

We wish to take occasion at this time, however, to mention, casually, one producer bug-a-boo that has been the cause of

considerable anxiety in the past, but which we believe to be at the present time strictly within the class of those things that are thoroughly understood. We refer to the question of hydrogen content for producer gas. Several years ago every manifestation in a producer-gas layout that was not thoroughly understood was attributed to the presence of hydrogen in the gas. It has probably been held responsible for more different kinds of trouble than any other single element, and has in all probability been responsible for few, if any, of the various deeds of evil that have been laid at its door. We will take pains at this time to enumerate a few of these features, as it is quite possible that they may come up again from time to time to cause aggravation and annoyance, and perhaps throw discredit on producer-gas power.

Several years ago, back-firing was a very common fault of producer-gas operation, and this was almost universally attributed to excess hydrogen. It has, however, been fully demonstrated that hydrogen in the gas is never responsible for back-firing. This condition may be produced by a number of defects, chief among which we would mention the presence of unplugged indicator and relief cock openings communicating with the combustion space, faulty location and timing of the ignition mechanism, or the overheating of either metal surfaces or carbonized oil within the combustion space. Pre-ignition of the compressed charge is another matter for which hydrogen was long held responsible. It was maintained that owing to the extremely inflammable nature of hydrogen, it would frequently ignite during compression, causing excessive pounding and other similar unpleasant manifestations. The writer has yet to observe a single authentic case of pre-ignition that was due to the presence of hydrogen. We have personally observed the operation of engines on which the compression was run up experimentally to as high as 220 pounds per square inch when supplied with gas containing 27 percent free hydrogen, without any sign of pre-ignition. On the other hand, we have had violent pounding on engines with not over 125 pounds compression, when operating on gas containing not to exceed 12 percent hydrogen. When we consider that the ignition temperature of hydrogen is only a little over 100 degrees lower than that of carbon-monoxide, and that if we assume the most unfavorable condition, namely, a temperature on the charge at the beginning of the compression stroke of 212 degrees F., and strictly adiabatic compression with no loss of heat, a compression of something over 300 pounds per square inch would be required to reach the ignition temperature of hydrogen. The improbability of pre-ignition from this source is immediately apparent. One characteristic of hydrogen, however, must not be lost sight of, namely, the fact that flame propagation is very much more rapid through hydrogen than through carbon-monoxide. In other words, an explosive mixture containing a high percentage of hydrogen will be completely burned in a very much shorter time after the occurrence of the igniting spark than would be the case where the hydrogen percentage is low and the combustible gas largely carbon-monoxide. A sudden variation in the hydrogen in producer gas may be the cause of violent pounding, not through any spontaneous ignition of the charge from compression, but on account of the more rapid rate of flame propagation having the effect of abnormally advancing the time of ignition, the resulting pounding being due to the fact that the igniter is set quite too early for the correct ignition of a mixture with so high a rate of flame propagation. It may be stated, therefore, as a fairly well-established fact, that a properly designed gas engine will handle producer gas with any possible continuous percentage of hydrogen without any irregularity in operation whatever, and that whatever irregularities may be traced to the hydrogen content of the gas are due rather to the variation in percentage of hydrogen than to the actual amount present.

TRIALS OF THE JAPANESE ARMORED CRUISER IBUKI.

The Japanese armored cruiser *Ibuki* has recently completed a series of very successful steaming trials at the Kure Navy Yard in Japan. This vessel is equipped with Curtis marine reversible turbines, built by the Fore River Shipbuilding Company, Quincy, Mass., which were shipped to Japan and installed in the vessel at the Kure yard.

The turbines drive twin screws, and are of 12 feet pitch diameter, with seven stages. They were guaranteed to deliver 21,600 brake-horsepower. The table given below shows the results obtained on the various trials.

The contract guarantees were made on a basis of 250 pounds steam pressure and 28 inches vacuum at 200 revolutions for two-fifths power and 255 revolutions at full power. The actual trial conditions were somewhat under these, and the corrected water rates in the table are to allow for the differences.

The reversing power of the turbines was tested at the end of the four-fifths power run by running astern for fifteen minutes, keeping the same firing interval and conditions in the boiler room as were used in going ahead. The turbines ran reversed at 186.3 revolutions, and developed 11,035 brake-horsepower. Also the general maneuvering qualities of the vessel were excellent.

The Fore River Shipbuilding Company have also supplied Curtis turbines for the battleship *Aki*, and Japanese yards are building Curtis turbines for two other battleships and three scout cruisers; two of the latter being ordered as a result of the successful outcome of the *Ibuki* trials.

Each of the turbines of the *Ibuki* has seven ahead wheels and two reverse wheels, all in one casing, and each in a compartment formed by diaphragms inside the casing. The first ahead-wheel and each of the reverse wheels has four rows of moving buckets, while the remaining wheels have three rows each. The steam leaving any wheel is directed through nozzles in the diaphragms onto the buckets of the next wheel. The turbines are reversed by simply shutting off steam from

TABULATED RESULTS OF OFFICIAL TRIALS OF THE JAPANESE CRUISER IBUKI.

	1/5 Power.	2/5 Power.	3/5 Power.	4/5 Power.	Full Power.
Duration of trial, hours	8	8	24	6	6
Steam chest pressure gage	221	228	230	240	239
Quality of steam	Sat.	Sat.	35° Sup.	28° Sup.	53° Sup.
Exhaust shell vacuum, inches	28.1	27.5	27.2	26.4	25.7
Revolutions per minute	151.2	189.1	215.7	235.5	250.5
Brake-horsepower	5,077	10,077	15,730	20,978	27,142
Water per hour for main turbines, pounds	108,021	183,083	256,910	330,339	407,987
Water rate per brake-horsepower, pounds	21.27	18.17	16.35	15.73	15.03
Available British thermal units in steam	348.	337.	341.5	329.	325.8
Efficiency of turbines, percent	34.3	41.6	45.5	49.2	52.
Water rate corrected to contract conditions	.....	16.76	.....	.....	13.88
Guaranteed water rate	.....	17.	.....	.....	15.

the ahead steam chest and opening the valve to the astern steam chest.

The above turbines of the *Ibuki* are similar to those on the United States scout cruiser *Salem*, except that their pitch diameter is 2 feet greater.

The Operation and Management of the Parsons Marine Steam Turbine as Practiced on the U. S S. Chester.*

BY LIEUTENANT A. F. H. YATES, U. S. N.

The turbine installation on the *Chester* is of the standard type designed by the Parsons Marine Steam Turbine Company. There are six ahead turbines, a high-pressure cruising, intermediate-pressure cruising, two main high-pressures, and two low-pressures. There are four independent shafts, each fitted with a single, solid, three-bladed propeller of 6 feet diameter and 6 feet pitch. Reversing turbines are incorporated into the exhaust ends of each of the low-pressure turbines. A reference to Fig. 1 will make clear the arrangement of turbines on shafts and the piping leads. The high vacuum maintained is assisted by the use of the Parsons vacuum augmenter. Independent air pumps are installed, with connections to the condensers through water seals. (Fig. 2.) The vacuum augmenters are virtually steam jets so arranged as to siphon the air from the condensers at a point just above the water level and deliver it to the water seal for the air pumps to handle, at a pressure of from 1 to 1 3-10 inches of mercury higher than the condenser pressure. The discharge from the siphon passes through a small condenser for condensation and reduction in temperature. The system of lubrication installed provides for the supply of oil to thrust bearings, main bearings and spring bearings at a pressure of about 10 pounds. The oil is supplied by steam-driven oil pumps and passes first through coolers on its way into the supply main. Separate pipes from the main pipe to the different bearings conduct the oil to the latter, and separate pipes take it away by gravity to common return mains, which discharge into the oil tanks in the bottom of the engine rooms. It is from these tanks that the oil pumps take suction. There are no valves in the system. The pipes which conduct the oil from the bearings have sight glasses in them, so that the flow of oil may at all times be under observation, and at the same points thermometers are attached to indicate the temperature of the oil as it leaves the bearings.

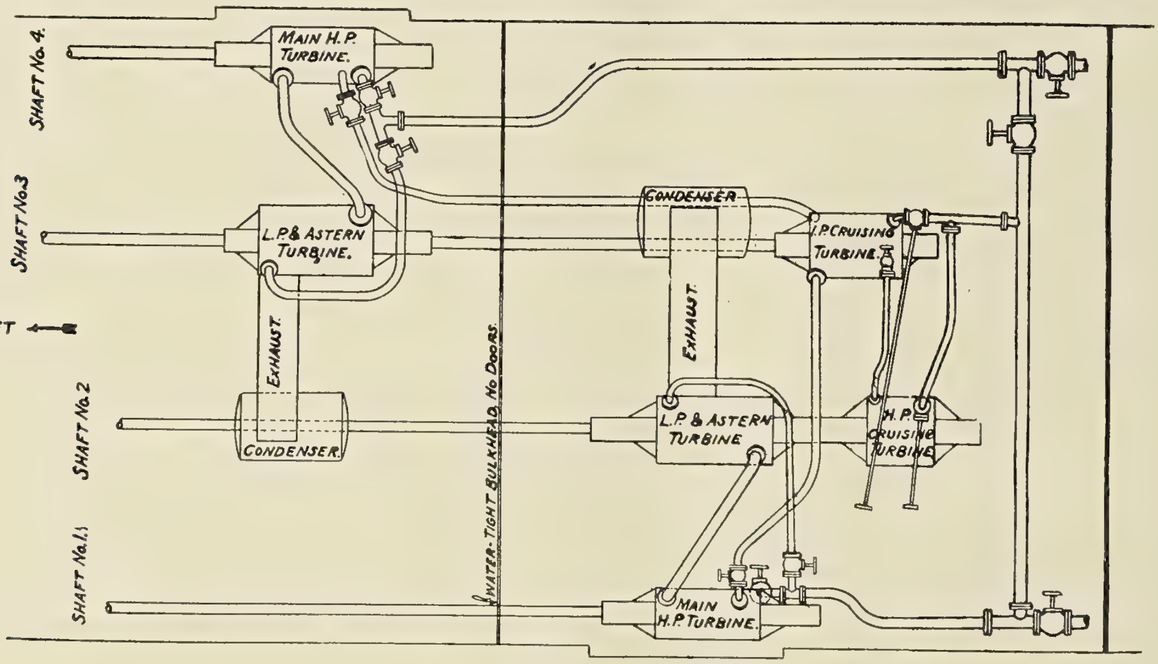


FIG. 1.

WARMING THE TURBINES FOR GETTING UNDERWAY.

The length of time necessary to properly prepare the turbine for trial is greater than for the reciprocating engine. Three hours and a half are usually allowed on the *Chester* from the time of beginning to warm up to the time of getting underway, though the turbines are generally tried and reported ready after 3 hours. They have been made ready in 24 minutes, and it is believed that they could be prepared in 10 minutes. That which is to be avoided is local heating and consequent uneven expansion. Steam is admitted to a circular steam belt, and in consequence the steam takes its initial direction over all parts of the rotor drum at the same time, and toward the exhaust end. At the exhaust end the steam leaves the turbine at the one point on the side of the casing where the exhaust pipe is connected. For this reason it might be expected that the near side would benefit by steam of perhaps somewhat higher temperature than that on the far side. In order to counteract any ill effects which might result from such cause, it is considered advisable to utilize the jacking gear while warming up, turning the shafts one-quarter or one-half a cycle every half hour. In order, too, that the greatest possible benefit may be derived from the heat of the steam, it is considered a wise practice to keep an extremely low vacuum, moving the air pumps as slowly as possible with safety. The various exposed parts of the turbine not covered by lagging should be felt with the hand from time to time, as much can be learned in this way as to the uniformity of heating. The use of auxiliary exhaust steam for warming up was at one time considered, but the idea was abandoned.

Steam should be placed on the glands at the same time it is admitted to the turbines.

The general procedure of warming up the turbines on the *Chester* is as follows:

1. Open the drains of all turbines to the condensers and unseat all throttle valves and spring-loaded non-return valves.

* Abstracted from the *Journal of the American Society of Naval Engineers.*

2. Open main injection valves and overboard delivery valves. Start main air and circulating pumps, having circulating connections open to the vacuum augmenter condensers.

3. Crack the cross-connection valve in the communicating pipe between the auxiliary steam line and the main steam line in engine room, thereby putting steam on so much of the main steam line as is in the engine rooms.

4. Close turbine throttle valves and open throttle by-pass valves. Keep a low vacuum.

5. Regulate pressure on auxiliary exhaust line, opening its connection to the steam-gland system sufficiently to give a pressure on the glands of about 1 pound.

6. Examine the strainers on oil pumps and test both pumps. Note first the amount and condition of oil in the gravity-return tanks; draw off any water that may be in the tank. See that water service is on the oil cooler and on the water-jackets of the spring bearings.

7. Steam having been raised on the additional boilers to be put in use, connect them, and open the engine-room bulkhead stop valves, closing the cross-connecting valve between the main and the auxiliary steam lines. Close throttle by-pass valves, if desired, and continue warming up through the throttle valves partially unseated.

8. The turbines being warm, a set of micrometer readings for dummy clearances should be taken and entered in the log.

9. Open valves admitting steam to the vacuum augmenters. Disconnect jacking gear.

10. Start oil pumps, by-passing the oil around the cooler. It should continue to be by-passed until the ship is underway, and the oil has reached a temperature of 100 degrees F., otherwise it will be sluggish and fill the bearings with difficulty.

11. Speed up the air and circulating pumps and raise the vacuum, and when a good vacuum has been obtained, report the turbines ready for trial. Keep all drains open until well underway. When lying at anchor with banked fires, and with orders to keep the turbines warm, they should be jacked over at least once an hour. They remain warm a long time after securing, but steam should be kept on them. Fifteen minutes' notice is then considered sufficient.

TRYING THE TURBINES.

The turbines are tried separately at a low speed under light pressure, and if properly warmed they will move easily, and the chances of their giving trouble when opened out are none. In trying them "ahead slow," sufficient pressure should really be given the main high-pressure turbine to insure the turning of its accompanying low-pressure turbine by the exhaust of the former. This will not happen if the exhaust pressure is extremely low. The test of the backing turbines is frequently repeated several times, it being the case very often that a rather high-pressure is needed to turn them the first time. The cruising turbines should, of course, be tried out. These turbines are so much smaller than the others that they are almost certain to be warm if the others are, and no difficulty has ever been experienced with them. If there is any interference of the blading in any turbine, it will make itself evident by an intermittent rumbling or grinding noise, which, if very serious, will be very shrill. The ears should be strained when the turbines are first tried, in order to detect even the slightest noise, as a slight interference at such slow speed might increase and give trouble upon opening out the turbine. If at any time there is a reasonable doubt as to conditions, the turbine should be stopped promptly and given more time to warm up. No more than 15 or 20 minutes are apt to be lost by so doing.

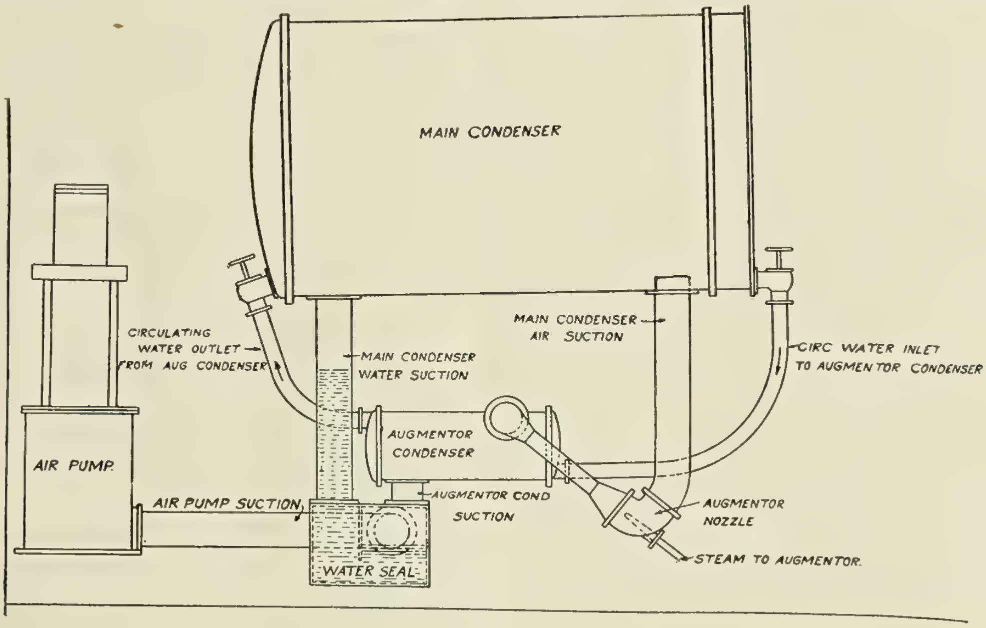


FIG. 2.

MANEUVERING, STOPPING AND STARTING.

Maneuvering is accomplished with much greater ease than with the reciprocating engine, as there is no reversing gear necessary to operate or to fail of operation. The operation consists simply of the opening and closing of valves, and consequently but very few seconds are ever necessary. The mistaken idea held by some who are not familiar with the turbine, to the effect that maneuvering is a lengthy operation, is entirely without foundation.

Full steam pressure may be admitted to the turbine as fast as the throttle can be opened, and the time elapsed to full open is but a few seconds. The valves should, most naturally, not be spun open with lightning speed, neither should they be opened irregularly by jerks, but they may, with perfect safety, be opened smartly and with precision, and a sluggish response to a signal is entirely unnecessary. During periods of rest it is a good idea to admit an occasional blast of steam into the astern turbines for the purpose of keeping them warm. They act more efficiently when warmed up thoroughly, and the admission of light blasts of steam can be accomplished without turning the shafts. Due to the fact that the astern turbines

are on the same spindle as the low-pressure ahead turbines, the dummy strips on the former must be of the radial type, whereas the latter are of the contract type. Fig. 3 illustrates the two types. The latter type permits of close and comparatively uniform regulation of the clearance. The former type is a permanent adjustment and cannot be as efficient, as it must permit of more elastic limits. But one of the two dummies can have the type suited to adjustment, and it is, of course, most important that the ahead turbine should

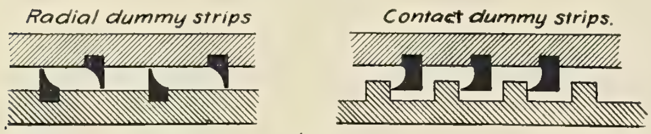


FIG. 3.

be the one so fitted. It is because of the type of dummy strips fitted in the astern turbines that more careful handling of these turbines is considered necessary; injudicious handling of the astern turbine throttle valves is particularly to be avoided.

If a reverse signal is received from full ahead to full astern, no anxiety need ever be felt. The valve to the astern turbine may even be started open while the ahead throttle is being closed, and, as the combined act requires so little time, the reversal may be considered as almost instantaneous.

If running under cruising turbines and a reverse signal is received, the execution of the signal involves no greater delay. Indeed, even less care is necessary than if the ship were running ahead under the main high-pressure turbines. This is because spring-loaded, non-return valves are fitted in the exhaust pipes, between the intermediate-pressure cruising turbine and each of the main high-pressure turbines. Steam is promptly cut off the cruising turbines, and, at the same time, the astern turbines' throttles are opened. Delay in attending to the former would cause no embarrassment, however, because of the valves above mentioned, which close automatically. In actual practice the non-return valve is usually closed by hand at the same time the remainder of the operation is being attended to. This should clear up any doubt as to occasion for accident, due to the number of turbines in operation.

Water in the turbines, due to condensation, or as a result of priming, need cause no apprehension. The drains are always open when maneuvering, and if the presence of water becomes known, it disappears almost as quickly as it comes. It is broken into small particles and passes out with the exhaust steam in the form of spray, causing no damage.

OPERATION WHEN FAIRLY UNDERWAY.

Reference is again invited to Fig. 1, in connection with a brief description of the manner in which the turbines are used for economical performance at different speeds.

First, for low speeds—up to about 18 knots—the steam passes through all six ahead turbines, both the high-pressure cruising and the intermediate-pressure cruising being connected up with the four main turbines. Steam admitted to the high-pressure cruising exhausts into the intermediate-pressure cruising, and from the latter it exhausts through separate exhaust pipes to each of the main high-pressure turbines. From the latter it exhausts into the low-pressure turbines, thence into the main condensers.

Second, for moderate speeds—up to about 23 knots—the steam passes through five ahead turbines; being admitted to the intermediate-pressure cruising turbine it exhausts, as before, into the main high-pressure turbines, thence into the low-pressures and into the condensers. The high-pressure cruising turbine revolves idly in a vacuum, its drains being open to the condenser.

Third, for highest speeds, only the four main turbines are used, steam being admitted to each main high-pressure turbine independently, and exhausting in each case through the connected low-pressure turbine and into the condenser. Both cruising turbines revolve idly in a vacuum, their drains being open to the condenser.

Reduction of power in each of the arrangements is obtained by throttling. Increased power is obtained by raising the pressure in the steam belt of the turbine which is being used as the initial stage. In the first arrangement, additional power may be secured through the use of a by-pass valve from the first to the second expansion, and also by admitting live steam direct to the intermediate-pressure cruising or to the main high-pressures. Similar increase in power may be obtained in the other arrangements. Ordinarily these alternatives are not used, though they are apt to be of benefit at any time.

The turbines should run without noise and without vibration. Such noises as have been mentioned above, if heard while the ship is underway, would indicate unusual conditions, which should be investigated immediately. As long, heavy turbines may whip slightly in a sea-way, due to the rolling of the ship or the racing of the screws, this might cause the blades to rub now and then and the turbine to groan or vibrate slightly. If the clearances of the dummies were very scant, the dummy rings might run a slight risk of grinding for similar reasons, but the likelihood of such an occurrence is very remote. Any grinding at this point would indicate too scant a clearance, and would be very serious, necessitating readjustment at first possible opportunity.

It would appear that greater readiness for service should be expected of the turbine than of the reciprocating engine, as overhaul is so seldom necessary and usually of a mild nature even then. Hardly any attention need be paid the turbine proper once it is underway, and no injury to attendants need ever be expected. The advantage resulting from the purity of the steam and its freedom from oil extends to the boilers, condensers and feed-water heaters. Barely any cylinder oil is used on the auxiliaries in the engine room of the *Chester*, a mixture of graphite and kerosene proving satisfactory for these engines.

In smooth weather a constant initial pressure, with a steady vacuum, corresponds to a constant speed, but varying conditions of wind and sea, or great variations in boiler pressure, have a detrimental effect in this respect. So long as the boiler steam is dry no variation in initial pressure for a constant speed is necessary, but when, with a drop in pressure, the steam becomes wet, the effect is felt at once. For this reason the fire-room force must be trained especially to preserve fairly constant limits of pressure. The effect of wind and sea is really marked, and higher pressures become necessary for the same speed, with constant loss in economy. This is against the turbine, but in spite of it the turbine ship is admirably fitted for heavy-weather work. The turbines do not labor or require throttling, but run with ease, and adapt themselves freely to the changes. It may express their action best to say that they appear elastic under such conditions.

With a sudden change in speed it is found that the turbine does not firmly establish itself to the new conditions for some considerable time. The proper pressure to carry for a specified number of revolutions per minute cannot be exactly determined for nearly an hour, though, of course, one suitable for the approximate speed can be found in a very few minutes; that is to say, within a quarter of a knot and less.

Running on a standard number of revolutions per minute is attended with the difficulty of ascertaining from time to time how many revolutions are being made.

Once the speed is established, however, it is maintained constant with comparative ease, though the man at the throttle must ever be at his station with his eye on the pressure gage,

The *Chester* picks up headway with lightning rapidity. While this, to a large extent, is due to the fineness of her lines, it is also due to the turbine installation. Maneuvering from rest should be harder with a ship having small propellers, but the turbines may be given steam so quickly and they reach their speed so quickly, that I believe for quick ahead action they are, on the whole, superior. I would not like to say the same for astern motion, however.

The two most essential points in connection with the economical operation of the turbine are undoubtedly dry steam and a high vacuum. The *Chester's* boilers furnish a high quality of dry steam, and no ill effects from this source are experienced as a rule.

As regards a high vacuum, the reason for its importance lies in the fact that the steam undergoes a greater range of expansion in the turbines than in the reciprocating engine. I might say, roughly, that for 1-inch drop of vacuum on the *Chester* her speed will drop off half a knot.

The provisions made for the utilization of auxiliary exhaust steam in the turbines have already been referred to above. There are many different conditions under which the auxiliary exhaust steam might be used, sometimes in one place and sometimes in another, depending upon the relative pressure conditions. The advantage to be derived should, however, be determined before it is used. Under some circumstances, as will be shown later, the auxiliary exhaust is drawn off to feed the gland system. Then again it may be used in the feed heaters. If it is used for these purposes there are not many occasions where it will be found sufficiently plentiful for additional use in any of the turbines. Therein lies a question as to whether greater benefit is derived from its use in the feed heater or in the turbine. I am hardly prepared to speak authoritatively in reply thereto. Benefit is derived in each case. Conditions have been noticed on the *Chester* where its application to the turbines resulted in a half knot increase in speed; whereas, on the other hand, its use in the feed heaters would have provided feed water of a temperature of 230 degrees F. or 240 degrees F.

The gland system on the turbines is one which requires more or less constant attention. As installed on the *Chester* it consists of a main pipe, which passes the entire length of the two engine rooms, forward and after. Branch pipes connect it with each gland of all the turbines, twelve in all. The only valves in the system are on the main pipe. There are two cutout valves, one to isolate the portions of the main pipe which lie in the respective engine rooms, to permit of independent management, and one to isolate the extreme end of the main pipe which lies abreast the cruising turbines. Neither valves are ever closed, as the gland system is worked as one unit and independent management in the two engine rooms not attempted; the one for isolating the cruising-turbine gland system would only be used in the event of those turbines being disconnected from the main shafts. There is, therefore, free communication in the system between all glands. The only other valves are one in each engine room for the admission of auxiliary exhaust steam to the main pipe, and a valve in a branch pipe to the condenser with which to relieve any excessive pressure on the system. In order to thoroughly understand the management of the system one must first have a clear understanding of the functions of the glands, especially as these functions are dependent upon existing conditions. The steam gland is, of course, the counterpart of the stuffing box on the reciprocating engine, and is intended to prevent leaks. While some of the glands tend to blow steam, others tend to suck air. The amount of steam leakage from glands under internal pressure depends upon the efficiency of the same and cannot be entirely avoided. The effect of the leakage of air through the others into the turbine will be noticed by a drop in the vacuum. As was stated above, the glands are all in free internal communication through the gland-system piping, so the leak-off steam from glands under internal pressure finds its way to the other glands and has the effect of sealing them against air leakage. Some of the steam leakage enters the atmosphere, but that cannot be avoided with the type of gland fitted. The amount of leak-off steam which enters the system is not always sufficient to seal the other glands, and in such cases auxiliary exhaust steam must be used in addition. On the other hand, the leak-off steam is under some conditions excessive, and it is then that the gland relief valve is opened to draw off the surplus to the condenser. About 1 pound steam pressure per gage is ordinarily used on the gland system, with good results.

In view of the high speed at which the shafts revolve, a constant and vigilant watch must at all times be kept on the bearings and on the oil system. Care of the bearings and of the oil service equals in importance the skillful warming up of the turbines for service. The main bearing journals are so constructed that, in the event of the babbit melting, certain raised portions of the brass will take the weight of the shaft during the time necessary to slow down and stop. This is in order to save the stripping of the blades, which otherwise would be a natural consequence. The use of the hose on the bearing casing when a hot bearing develops is a useless alternative, though after the turbine is stopped it can do no harm to reduce the temperature. Sight glasses are fitted in all of the branch discharge pipes from bearings, and a glance at these shows whether or not the flow of oil is normal. Thermometers are also fitted at these points, and the temperature of the oil discharged from each bearing is readily observed. The oilers in making their rounds should not be guided entirely by these devices, but should feel each bearing with the hand. No calculations have been made on the amount of oil required for operation, but the tremendous oil-saving with the use of turbines is most apparent. A precaution that should be observed is the daily inspection of the gravity-return oil tanks when in port for the presence of grit, dirt or an excessive amount of water. The water can be drawn off, but if it is excessive, steps should at once be taken to ascertain where it comes from. It should not come from the coolers, on account of the oil pressure being greater than the water pressure, but this is one place that should at least be inspected. Another place is in the water-jackets on the spring bearings. The water should, of course, be tasted first, to determine whether salt or fresh. It is surprising how much water may be expected from sweating.

The marked effects of cavitation supposed to exist when high power is reached exist more in fancy than in fact. The second standardization trial of the *Chester* conclusively proved that she had made all speeds that had ever been claimed for her. The efficiency of the propellers falls off at the higher speeds, but not to an alarming extent, and no evidence of their breaking down or of erratic behavior has ever been detected. New propellers of even greater disc area are to be fitted later, and slightly greater speed is expected.

My remarks on operation must be brought to a close after mention of the following points to be observed when securing the turbines after coming to anchor. Steam should be tightly shut off the glands and off the vacuum augmenters. Special precautions should be taken to see that water service is kept on the vacuum-augmenter condensers, however, and the main air and circulating pumps should be run for about 3 hours after steam is shut off the turbines. The latter is necessary, as hot vapor remains in the turbines and develops for a considerable time after the steam and water has been drained out, and the condensers might be damaged if secured too early; even after securing, condensation continues for a considerable length of time, for the turbines remain more or less warm from 12 to 24 hours, depending on the surrounding temperature.

THE MARINE STEAM ENGINE INDICATOR—III.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

THE SCOTT-RUSSELL MOTION AND MECHANISM DERIVED FROM IT.

If the reader will provide himself with a flat carpenter's square, a thin batten, a pencil and a couple of round hardwood points, he will have the means for graphically analyzing this motion in a most interesting manner. Drill three holes on the center line of the batten, *A* and *E*, near the ends and *C*, midway between them, so that *AC* equals *CE*, as shown in Fig. 21. Insert the sharpened hardwood points in *A* and *E* and

FIG. 21.

a pencil in *C*. See that the points are all accurately in line and equidistant, with the pencil point a little longer than the end points. All three points should be sharpened with the same degree of taper.

Place the square on a smooth sheet of paper, resting on a plane surface. Take the batten in hand, holding the point *E* in the inside corner, and the point *A* against one of the legs of the square, so that the pencil is perpendicular to the plane of the paper, all as shown in Fig. 22. Now, keeping the

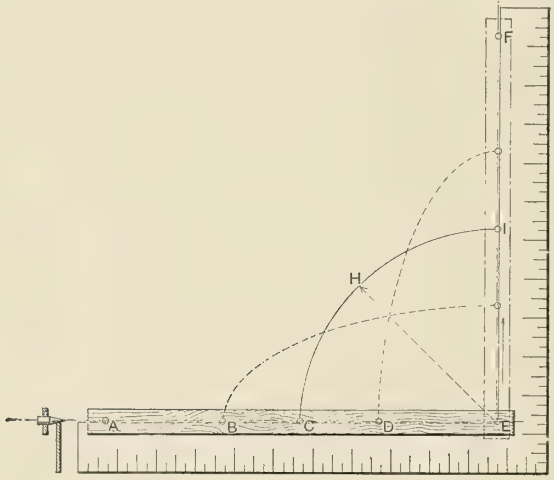


FIG. 22.

wooden points *A* and *E* in contact with the square, move the point *E* in the direction of the arrow until it reaches *F*. The batten will then occupy the position shown in dot and dash lines. During the movement described the pencil will have traced the arc *CHI*. This arc will be truly circular, with a radius *HE*, the center being at *E*. If now the pencil be removed to any other hole on the center line of the batten, as *B* or *D*, and the movement repeated, as before, the arcs traced will be elliptic in every case, as shown by broken lines in the figure.

Consider the slider-crank mechanism shown in Fig. 23. This is the Scott-Russell parallel motion proper. The pin *C* is in the middle of *AE*, and the link or crank *CG* is equal in length to one-half of *AE*. Here, the point *A* is constrained to move in the straight line *AG*, as in Fig. 22, and the point *C* in a true circular arc by the crank *CG*. Likewise, every other point on *AE*, except those at the ends, will describe elliptic arcs, as shown at *BB'* and *DD'*. The marking point is at *E* and draws the accurate straight line *EG*, which corresponds with the leg *FE* of the square in Fig. 22.[3] The similarity of the two motions will be readily understood without further description.

In order to adapt this mechanism to the indicator and avoid introducing mathematical errors, the arrangement shown in Fig. 24 might be used, the pencil lever *AE* being offset between *C* and *E* to allow the scribing point to pass the fulcrum *G*. With this arrangement the pencil or scriber path *EF* will be an accurate straight line normal to the line *AG*, as has heretofore been demonstrated. The piston rod, whose center line *PP'* is parallel to the pencil path, is connected to *AE* by the slotted

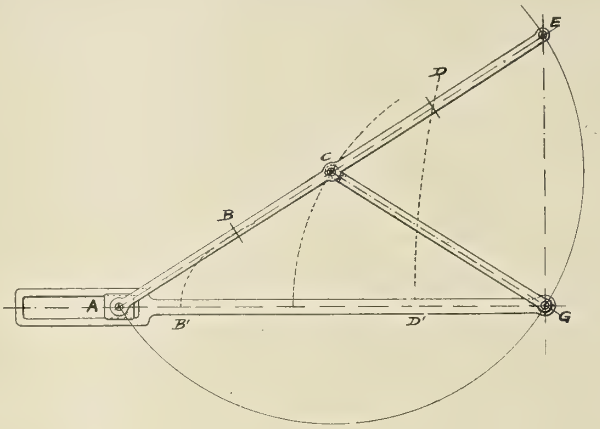


FIG. 23.

crosshead and pin at *B*, the rod being guided in its rectilinear path by the sliding pair at *D*, and by the cylinder and piston. As the distances x and y, measured parallel to *AG*, are always proportional,[4] the velocity ratio $\left(\dfrac{x + y}{x}\right)$ between the piston and pencil will be constant in all positions of the mechanism.

This movement, although mathematically exact, is not considered mechanically practical, and, so far as we know, has

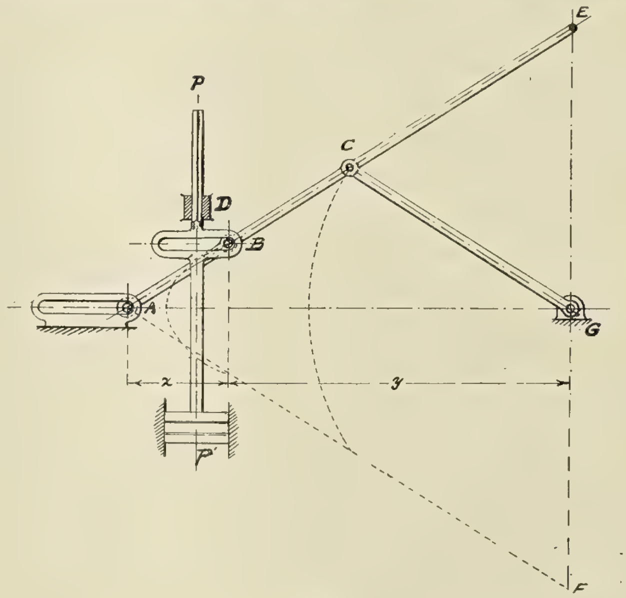


FIG. 24.

never been actually used on any indicator. A link turning on pin joints is always used in place of the sliding pair at *A*, and the piston rod is connected to the pencil lever in the same manner. While this makes a better mechanical arrangement,

[3] The points *AGE* lie in the semi-circular arc whose center is at the movable point *C*, and this holds true in every position of the mechanism. As every angle inscribed in a semicircle is a right angle, *EG* is always a straight line passing through *C* and normal to *AG*.

[4] By the theorem of proportional triangles.

mathematical errors are at once introduced. A pencil mechanism, fitted with the substitutions mentioned, and which most closely resembles the arrangement in Fig. 24, is shown in Fig. 26.

For convenience of reference we shall hereafter call the link *AB* (Fig. 26) the "back link," *CD* the "piston rod connecting link," *EF* the "front link," *AP* the "pencil lever," *xx'* the "horizontal axis," and 1-5 the "pencil axis."

In the mechanism of Fig. 26, the front link is half as long as the pencil lever, and is paired to the latter at its middle point by a pin joint, as in the Scott-Russell motion; but the pencil is

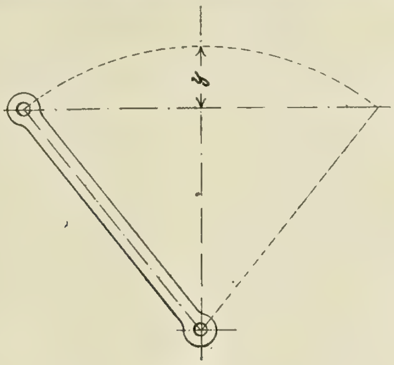


FIG. 25.

caused to deviate from the accurate straight line of that motion by the versed sine *y* (Fig. 25) of the back link. This link (*AB*, Fig. 26) is so located that the versed sine is inclined and the scribing point *P* crosses the pencil axis at 1, 2, 3, 4 and 5, the intervals being equal. The actual pencil path is much exaggerated in the figure in order to show its general form. The piston rod link *CD* is parallel to the back link when the mechanism is in the position shown, and the points *B, D* and *P* are in the same straight line. It follows, from what has been said of the pantograph, that whenever the

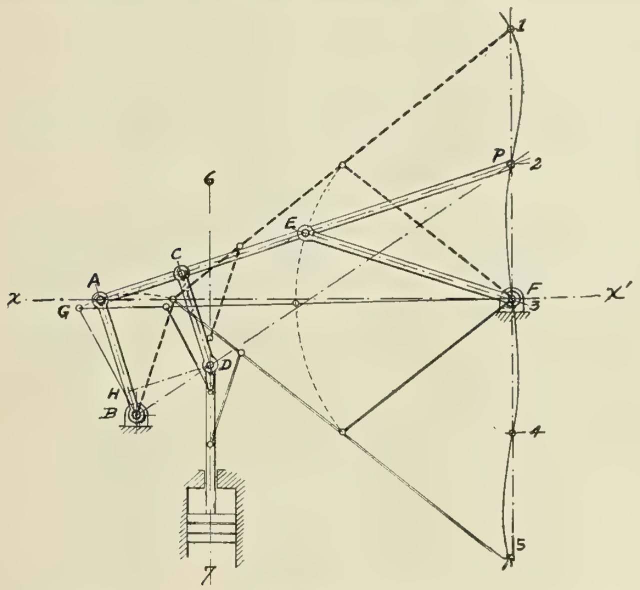


FIG. 26.

points *P* and *D* are on the parallel lines 1-5 and 6-7, the front and back links will be parallel, *AC* and the imaginary link *HD* will be parallel and of equal length, and the velocity ratio between the piston and pencil will be constant. Whether the front and back links are in proper adjustment proportionately on the five points is seen to depend on the accuracy with which the piston follows the line 6-7, which is parallel with 1-5. The accuracy with which the pencil follows its designed path depends entirely on the front and back lines, and is independent of the piston-rod guide. As the mechanism is absolutely correct at five equidistant points on the pencil axis, it is believed to be one of the most accurate of all the approximate motions. The heavy, broken lines show the mechanism in its highest position with the pencil at 1. The fine, unbroken single lines indicate the position of the links

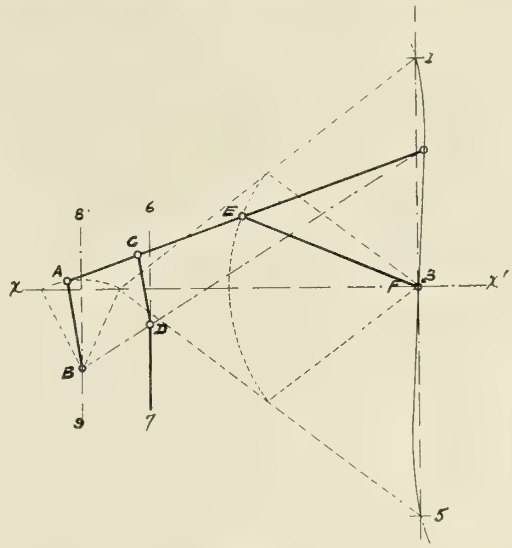


FIG. 27.

with the pencil at 3, and the fine double lines the lowest designed position of the mechanism with the pencil on 5.

Referring again to the back link: If this link be located so that the versed sine falls on the line 8-9 (Fig. 27) and is entirely above the horizontal *xx'*, the pencil will cross the pencil axis three instead of five times, and will have but three points where the movement is absolutely correct. Locations of the back link, intermediate to those shown in Figs. 26 and 27, will result in "five-point" mechanism, but the crossing points will not be evenly spaced.

This mechanism is still further altered in many designs by

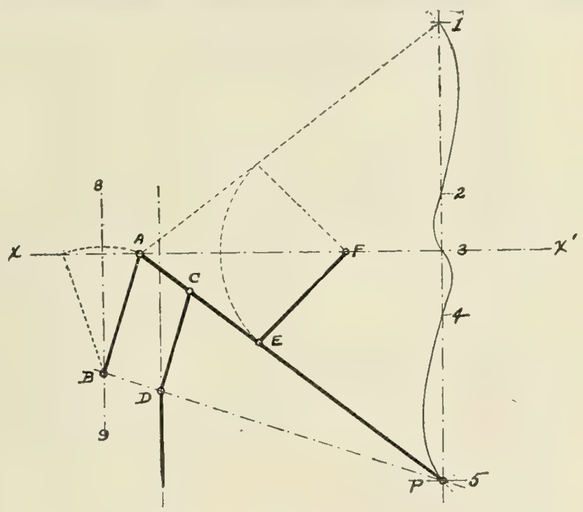


FIG. 28.

shortening the front link and locating it at a greater distance from the scriber end of the pencil arm, as shown in Fig. 28. The path of the point *E* should be elliptic, but it is constrained to move in the arc of a circle whose center is at *F*. As the difference between the circle and ellipse at this point and within the limits used is small, the error introduced is inconsiderable. The characteristic pencil line traced by this mechanism is shown in exaggerated form in the figure. In some instruments, even the location of the point *D* on the line

BP has been changed, and *CD* made as long as possible by locating *D* close to the piston, the arrangement being similar to that formed in "trunk" engines.

In another form, the front link is paired with the piston rod connecting link at *E*, as shown in Fig. 29. If *P* is made to follow the straight line 1-5, the path of *E* is neither a circle nor an ellipse, but a curve of a higher order; it is so close to a circular arc, however, that (within proper limits and on the scale used) the difference is not measurable. In order that the pencil may follow its designed path in this arrangement it is most important that the piston-rod guide *H* be kept in good order, as any lost motion at this point will cause a large pencil error. Mechanisms in which the front link is made shorter than one-half the pencil lever have a certain advantage, other things being equal, in that the weights have a shorter motion at lower speed than in those instruments fitted with the non-shortened front link.

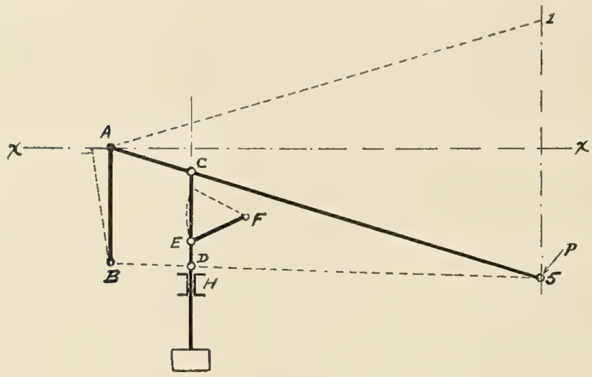


FIG. 29.

MECHANISM WITH PENCILS CONSTRAINED BY SLIDING PAIRS.

Several makes of instruments have the pencil mechanism shown in the conventional sketch, Fig. 30. The pencil point *P*, is guided directly by a straight slide, the links are so proportioned that the pins at *B* and *D* are in line with *P*, and *AB* and *CD* are parallel. These conditions are constant, so long as 1-5 and 6-7 are parallel, and the motion is therefore absolutely correct when properly adjusted. Another well known movement of this sort is shown in Fig. 31. The proportions of the various links are as in Fig. 30. The shape of the curved slot *EE'* is derived as follows: If *P* be guided accurately on the straight line 1-5, the pin *E* will mark out a peculiar curve, which will be neither a circle nor an ellipse owing to the disturbing effect of the back link. Conversely, if a guide be made of the exact shape marked out by *E*, as just described, and this guide be made to constrain the motion of the pencil lever, the pencil *P* will draw an absolutely straight line. From the description of the shape of the guide and an inspection of the diagram, it is seen that this mechanism is absolutely correct, both in its straight-line motion and constant velocity ratio.

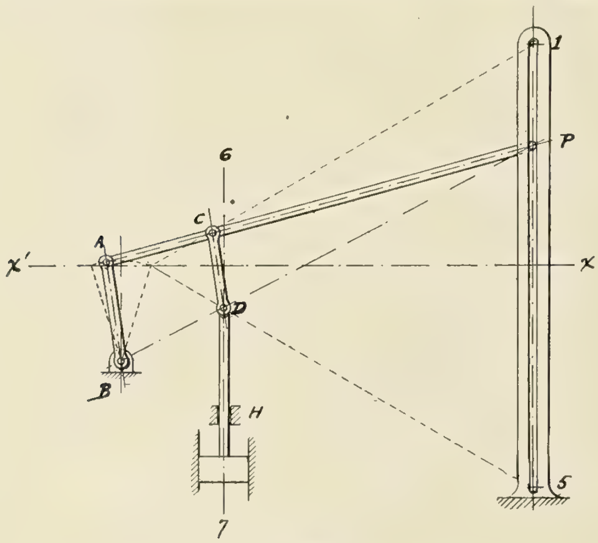


FIG. 30.

Lack of space forbids the description of a greater number of these mechanisms, and, moreover, those described cover the majority of instruments now in use. Many devices additional to those shown have been made, and there is no difficulty in designing still more of them, but it would be hard to improve on the best of those now in use. The sketches heretofore shown are not to be taken in any sense as detailed drawings, but as conventional sketches, only intended to show general principles.

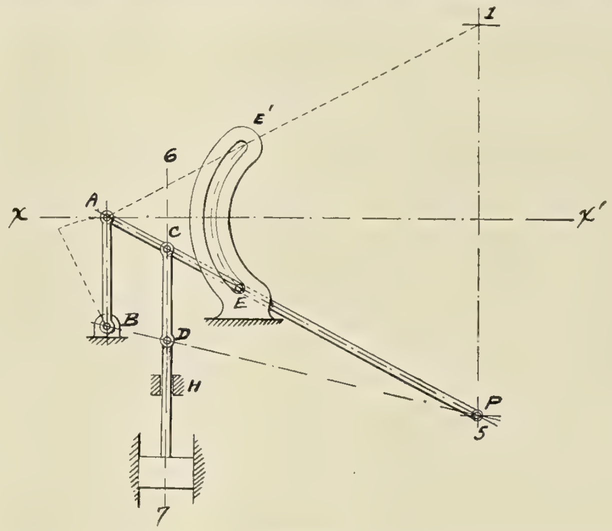


FIG. 31.

(*To be continued.*)

Economy of Turbines vs. Combined Reciprocating and Turbine Propulsion.

Sir Christopher Furness, M. P., recently had the machinery of his steam yacht *Emerald* converted so that the three-turbine, three-propeller system was changed to a combined high-pressure reciprocating engine and low-pressure turbine. The following table, published by the *American Machinist*, has been given out by Sir Christopher Furness to give figures for comparison of these two forms of propulsion:

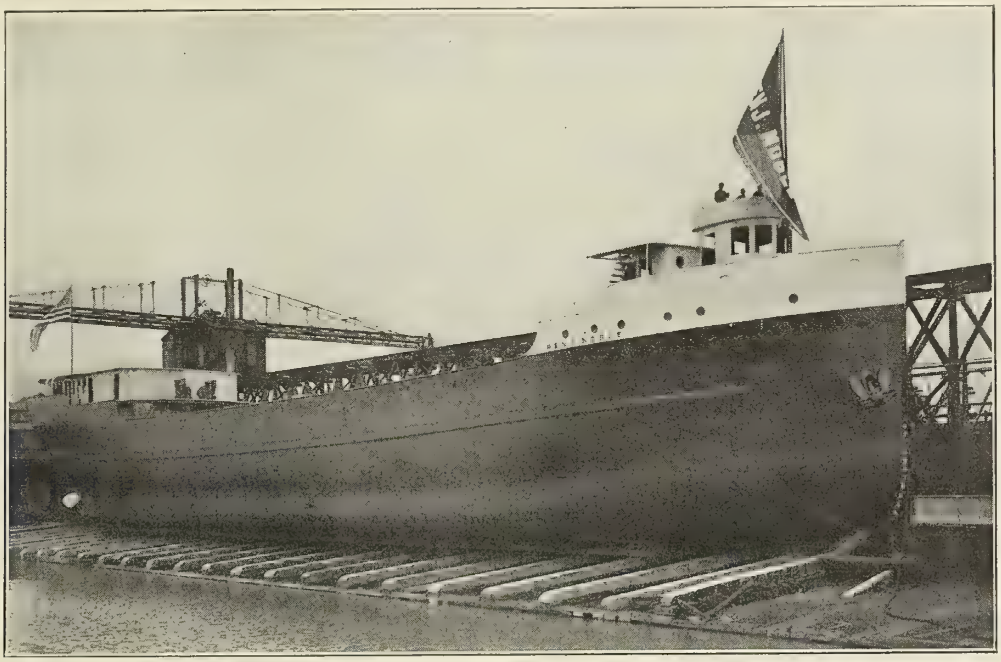
Speed.	Consumption.	Steam Pressure.
	BEFORE.	
10 knots.	18 tons.	150 pounds.
11 "	23 "	145 "
12 "	25 "	140 "
13 "	28 " (?)	. . .
	AFTER.	
10 knots.	13 tons.	150 pounds.
11 "	16½ "	150 "
12 "	20 "	150 "
13.2 "	22.9 "	150 "

It will be seen that in the first table the steam pressure varied, whereas in the second it was constant at 150 pounds. This makes comparison somewhat difficult, but it is safe to point to the top line in each set of figures; namely, that relating to a speed of 10 knots, when, with a steam pressure of 150 pounds, the consumption figures are 18 and 13 tons. Thus, with the converted machinery the steam consumption was

rather less than three-fourths the consumption with the three-turbine system. Generally speaking, the other figures are of the same order, although the comparison is not in every case quite so pronouncedly to the advantage of the cited combination plan.

A NEW LAKE STEAMER.

The Capital Transportation Company, of Detroit, Mich., recently launched a new ship, the *Benjamin Noble*, at the yards of the Detroit Shipbuilding Company, to enter the pulpwood trade. The ship is within a few inches of the maximum length capable of passing through the Welland Canal and locks. She is of the regular lake type, built extra strong, and is suitable for deep-sea navigation should occasion demand. The deck and hatches are built extra strong, in order to sustain the heavy deck loads which will be shipped in the pulpwood trade. Railroad iron can also be carried. The hold of the ship is one large compartment.



THE BENJAMIN NOBLE READY FOR LAUNCHING.

HULL DATA.

Length between perpendiculars....	240 feet.
Length over all....................	256 feet.
Breadth, molded..................	42 feet.
Depth, molded.....................	18 feet.
Indicated horsepower..............	800
Speed	11 miles per hour.

The hull is built of mild, open-hearth steel, the sides having a tumble home of about 3 inches at the foot of the bulwarks. Between hatches the structural design is particularly heavy. The floors are spaced 36 inches apart. The bilge radius is 36 inches, and wharf protection is afforded by an oak stringer 9 by 6 inches.

PROPELLING MACHINERY.

The main engine is a three-cylinder, inverted, triple-expansion engine of 800 indicated horsepower. It is mounted on built-up girders of steel plate and angles. The low-pressure cylinder is located forward, the high pressure aft, with the intermediate between. The cylinder walls are 1⅛ inches thick. The pistons and cylinders are of cast iron. The piston rods are of steel, 4 inches in diameter, and the connecting rods of wrought iron, strap connected and babbitted. The crank shaft is built up of cast steel slabs with mild steel shafting and pins. The engine is designed to turn 90 revolutions per minute. The cylinders are 17, 24½ and 46 inches diameter by 36-inch stroke. The valves are actuated by the Stevenson link motion, and the main steam pipe is 7 inches in diameter.

The steam-producing plant is forward of the engine room. It comprises two boilers, 11 feet 6 inches long by 12 feet diameter. Natural draft is used, and the steam pressure is 180 pounds per square inch. Each boiler has two furnaces, 42 inches in diameter, and 174 3½-inch tubes. The total grate surface is 75 square feet, and the total heating surface 2,700 square feet, giving an approximate ratio of 1 to 36. The boilers are arranged athwartship in the stokehold, and are fired from the forward end. The coal is carried in bunkers alongside the boilers, the coal being distributed through a V-shape hatch over the boilers.

The *Noble* has a single cast iron screw, 12 feet in diameter and 12 feet 6 inches pitch, with four sectional blades.

AUXILIARIES.

The auxiliary machinery consists of a dynamo, direct connected in the engine room for lighting and four hoisting engines on the deck for loading cargo. The hoisting engines, ballast pump, main feed pump, steam windlass and two deck engines are all piped from the main boilers. The steering gear is the Detroit steam gear.

The crew's quarters are divided, part of the crew having quarters forward and the rest aft. The engineers' staff is housed aft, while the mates, wheelsmen, firemen and watchmen are housed forward.

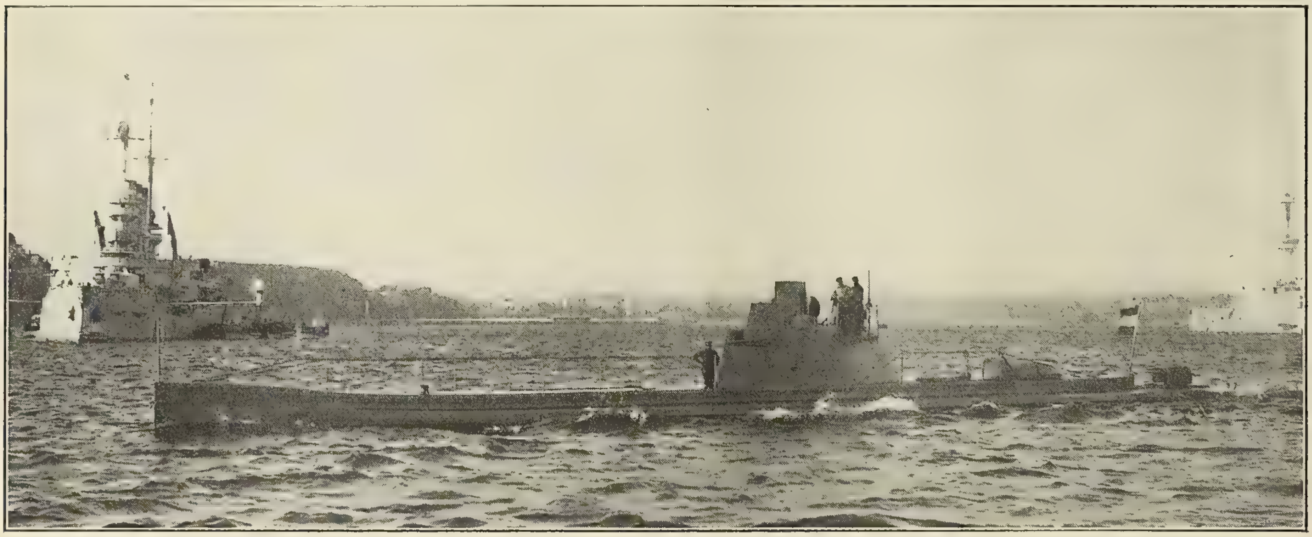
The Cunard steamship *Lusitania* has again lowered the time of passage across the Atlantic Ocean, having left Liverpool Saturday evening, Aug. 28, and landed her passengers in New York before 8 o'clock on Thursday evening, Sept. 2. The time from Daunt's Rock to Ambrose Channel Lightship was 4 days 11 hours 42 minutes, and the average speed 25.85 knots. This trip enabled passengers to land on the fourth day from Queenstown.

KRUPP SUBMARINES FOR THE AUSTRIAN NAVY.

BY FRANK C. PERKINS.

Two submarine boats for the Austrian navy have recently been built at Kiel at the Germaniawerft of Fried. Krupp Aktiengesellschaft. They have an under-water displacement of 300 tons and a surface displacement of 235 tons, their extreme length being 142 feet. The surface draft is 9 feet 8 inches, while the breadth is 12 feet 4 inches outside measurement of the double hull. The inner hull is a cigar-shape, watertight shell, having a structural strength calculated to resist the water pressure at a depth of 165 feet.

The watertight hull is constructed with nine welded circular sections, three of which at each end are slightly conical, while the three sections amidships are cylindrical in form. There are several watertight compartments provided, the hull being sub-divided by means of bulkheads with the torpedo armament in the bow section, the next being occupied by the electric storage battery room and a compartment for the crew, with galley and electric cooking apparatus. The sections amidships contain the inner ballast tank, while the stearing gear for the two pairs of diving rudders is located just below the conning tower. The next section is occupied by the engine room, containing the electric motors and the internal-combustion engine; storage battery installation being provided for in the last water-tight section.



NEW SUBMARINES FOR THE AUSTRIAN NAVY, DESIGNED TO OBTAIN SEAGOING QUALITIES.

The shape of the outside hull is similar to that of an ordinary torpedo boat, a weather deck extending the entire length of the craft, which is utilized by the crew when traveling on the surface. Most of the water-ballast pipes are fitted between the inside hull and the deck platform, as well as all the kerosene pipes.

For surface navigation the boat is propelled by two 600-horsepower, two-cycle oil engines, while two electric motors are provided for propulsion when the boat is submerged, the electric motors driving two reversible screws and developing 320 horsepower. There are two main bilge pumps and one auxiliary pump, all operated by electric motors, with two hand-operated bilge pumps installed in the engine room with the air compressors and other accessories.

A most interesting feature is the 5-ton safety keel, which can be detached simply by the movement of a handle working an ordinary gear. In order to prolong the stay under water and to reduce the liability of accident to a minimum, a number of appliances have been installed for purifying the vitiated air. On the outside plating air connections are arranged which would allow communication with the outside atmosphere under certain conditions, and the buoy is mounted on deck, and so arranged as to be unfastened from the inside of the hull, thereby establishing connection by telephone with a rescuing crew if found necessary at any time.

These Austrian submarines are capable of making 12 knots as a surface speed, the submerged speed being 8.6 knots. They have a radius of action of 60 miles at a speed of 6 knots when submerged, the radius of action above water being 1,200 miles, at an economic speed of 10 knots.

Each boat is provided with two torpedo tubes, and carries a supply of three 18-inch Whitehead torpedoes. Strong nickel-steel plates are used in the framing of the conning tower, amidships; these plates being capable of resisting the attack of small guns. All of the equipment for controlling the boats in action is installed in the conning tower, including two periscopes, the only opening being directly above the conning tower.

There is a conning platform for surface navigation arranged aft of the conning tower, the latter being enclosed in a structure designed to diminish the resistance when traveling under water, and therefore allowing ship-shape lines. It will be noted that there is a decided effort to obtain seagoing qualities in these submersibles.

MAST AND DERRICK MOUNTINGS.

LIFT AND PURCHASE BLOCKS FOR 25-TON DERRICKS.

Fig. 1 shows a treble lift and purchase block for a 25-ton derrick. The sheaves are 14 inches in diameter by 2½ inches

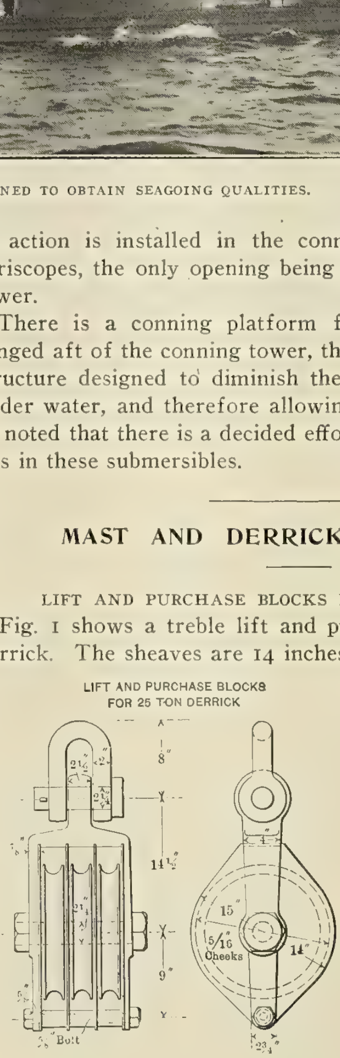


FIG. 1.

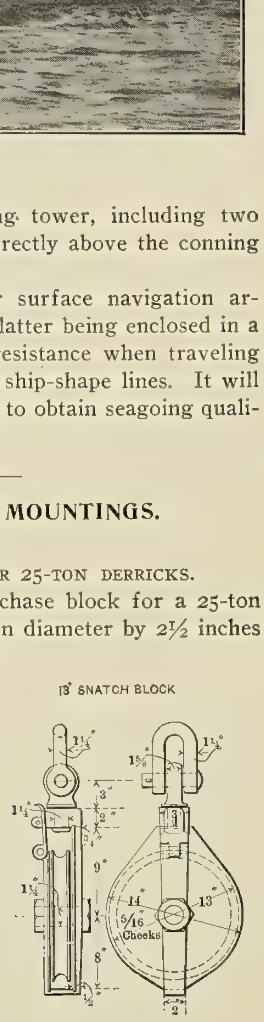


FIG. 2.

thick. The pin is 2¼ inches in diameter, grooved for oil and fitted with a feather at the head to prevent turning. A 5/16-inch screw is fitted in the nut to prevent loss. From the center of the sheave pin to the center of the shackle pin is 14½ inches; from the center of the sheave pin to the center of the bolt through the distance piece is 9 inches.

The head takes a 2-inch shackle, and is 2½ inches thick; the pin of the shackle is 2¼ inches in diameter, and is fitted with a split forelock pin. The jaw of the block at the crown is 4 inches broad by ⅞ inch thick; at the distance piece it is 2¾ inches by ⅝ inch thick. The checks are 5/16 inch thick; the division plates are ⅛ inch thick, and the overall width of the block is 15 inches.

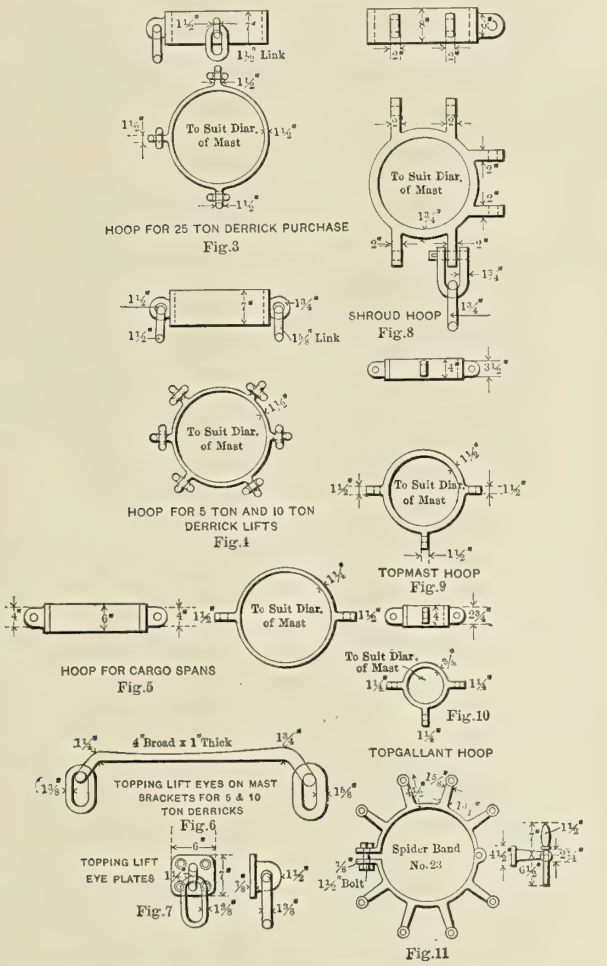
In drawing blocks for derrick arrangements, it is advisable to make inquiries as to which way the head of the derrick looks; one will be with the head as drawn, and the other with the head across the block, and two will be fitted with beckets.

A 13-INCH SNATCH BLOCK.

Fig. 2 shows the dimensions and details of construction of this block.

HOOPS FOR DERRICK LEAD BLOCKS, LIFTS, ETC.

Fig. 3 shows a hoop for taking 25-ton derrick purchase blocks. It is 7 inches deep, 1½ inches thick, and is shrunk on



to the mast; then the holes are carefully bored for rivets. Three eyes are shown in this case, 1½ inches in diameter to take 1½-inch links; to these links are shackled the lead blocks as detailed.

A hoop to take 6 derrick topping lifts, 3 on fore side of mast and 3 on after side, is shown in Fig. 4. The eyes to take 5-ton lifts are 1½ inches in diameter, with 1½-inch links to take double-purchase blocks. The eyes to take the 10-ton derrick lifts are 1¾ inches and the link is 1⅝ inches in diameter. Care should always be taken with those links, to see that shackles of the blocks ship and unship easily.

Cargo span hoops are shown in Fig. 5. The hoop is 6 inches deep, 1¼ inches thick, and two snugs are fitted to take the shackles of 4-inch S. W. R. stays. The snugs are 4 inches deep and 1½ inches thick.

Fig. 6 shows the usual method of fitting topping lift plates on mast brackets. The plate is 4 inches broad by 1 inch thick, and eyes are worked on each end. The eye for the 5-ton derrick is 1¼ inches, with 1⅜-inch link. For 10-ton derricks the eye is 1¾ inches, with link 1⅝ inches.

When each lift is fitted singly to the mast, the topping lift plates are as shown in Fig. 7. The sole of the plate is 6 inches broad by 7 inches deep and ⅞ inch thick; the eye is 1½ inches in diameter, and the link is 1⅜ inches in diameter. The sole is fastened with four 1-inch rivets. The proof test of this plate would be 28 tons.

Fig. 8 shows a shroud hoop with 4 snugs. The hoop is 8 inches deep by 1¾ inches wide; the snugs are 6 inches deep by 2 inches thick. The snugs are to take 1¾-inch shackles, and to the shackles are fitted 1¾-inch links, the links taking double 3½-inch shrouds. On the fore side of the mast are fitted two preventer stays.

A topmast hoop (Fig. 9) is made 4 inches deep, 1 inch thick, with 3 snugs, which are 3½ inches deep and 1½ inches thick, arranged to take 1-inch shackles. The stays are 3¼-inch S. W. R. Fig. 10 shows a topgallant hook, which is 4 inches deep by ¾ inch thick, with 3 snugs 2¾ inches deep and 1¼ inches thick. They are arranged to take the ¾-inch shackles of 2½-inch S. W. R. The usual hinged spider band, with 8 belaying pins, is shown in Fig. 11. It is 4 inches deep by ¾ inch thick. The detail explains itself.

A Marine Steam Turbine Reducing Gear.

Ever since the introduction of the steam turbine for ship propulsion numerous efforts have been made to improve the efficiency of turbines running at comparatively low speeds, in order to accommodate them to the most efficient propeller speeds. The result in nearly every case has been a more or less unsatisfactory compromise, since the turbine is essentially a high-speed engine, and its best efficiency and its lightest weight per horsepower developed can only be obtained at high speeds. To overcome this difficulty Rear Admiral George W. Melville, formerly chief engineer of the United States navy, has designed a reducing gear to be interposed between the turbine and the propeller shaft, so that the turbine can run at a comparativeley high speed, while the propeller shaft revolves at relatively low speed. According to the *American Machinist* the gear consists of a floating frame supporting two spiral gears of different diameters, the smaller of which is connected to the turbine shaft and the larger to the propeller shaft. An experimental gear of this type has been built at the shops of the Westinghouse Machine Company, Pittsburg, Pa., under the personal supervision of Admiral Melville and John J. Macalpine. It is designed to transmit 6,000 horsepower. The pinions are of steel, having a tensile strength of 90,000 pounds per square inch, and the gears are 22-inch face and 14 and 70 inches pitch diameter.

The pinions each have thirty-five teeth and the spur wheels 176, a hunting cog being introduced to equalize the wear. In order to secure comparatively noiseless operation a small pitch was necessary; the pitch in this case was made 1¼ inches, and the pitch helices were placed at an angle of 30 degrees with the axis of the shaft. One wheel and pinion have right-handed and the other pair left-handed helices, in order to eliminate end thrust on the shaft. The small pitch, of course, necessitated the use of broad teeth.

THE DESIGN OF TURNING ENGINES.

BY EDWARD M. BRAGG, S. B.

When engines are being overhauled, or when the valves are being set, it is often necessary to turn the crank shaft over. In small engines this can be done by means of a bar fitting into holes drilled in one of the coupling flanges. In larger engines, developing from 500 to 1,000 indicated horsepower, a worm and wheel such as is shown in Fig. 1 can be used, and in engines over 1,000 indicated horsepower it is customary to use two worms and two worm wheels connected to a steam engine of one or two cylinders (see Fig. 2). Such an arrangement gives a large multiplication of power in a small space and enables one to use small steam cylinders.

In Fig. 1 the worm is carried in an eccentric bearing, so that by turning the bearing the worm is thrown out of gear and the worm wheel is free to revolve with the crank shaft. In Fig. 2 the large worm C is attached to the shaft by means of

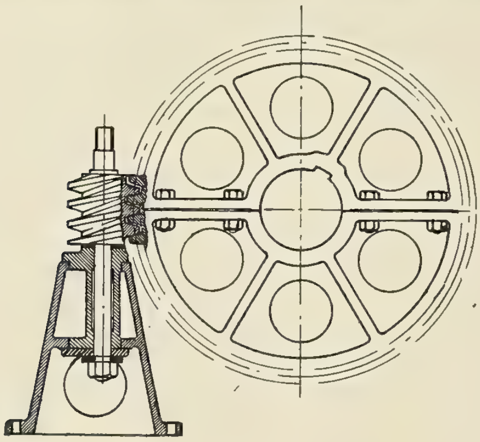


FIG. 1.

a removable key or pin, or in some other way, so that when it is not in use it can be screwed to the upper part of the shaft and the worm wheel D will be free to revolve. In some cases the shaft of the large worm is not fixed at the lower end, but is held by a rod operated by a hand wheel. The shaft has in the upper part a Hooke's joint, which permits the lower part of the shaft and the worm to be swung back out of gear.

In Fig. 2 the small worm A is keyed to the crank shaft of the turning engine, and drives the small worm wheel B. Upon the same shaft with the latter is the large worm C, engaging with the large worm wheel D, which is usually at the aft part of the engine, and when convenient is mounted upon the coupling between the crank shaft and the thrust shaft.

WORM WHEELS.

The turning engine should be of such size as to be able to turn the main engine over once in from five to ten minutes. The revolutions per minute of the engine are usually between 200 and 400, so that it will make from 1,000 to 4,000 revolutions for one turn of the main engine crank shaft. If the worm A, Fig. 2, on the turning engine crank shaft is single-threaded, the turning engine will have to make as many revolutions as there are teeth on the small worm wheel B in order to revolve it once. The same is true of the large worm C driving the large worm wheel D on the main engine crank shaft; hence the number of teeth on the two worm wheels must be such that

$$n\, n_1 = r\, m \qquad (1)$$

n = number of teeth on small worm wheel.
n_1 = number of teeth on large worm wheel.
r = revolutions per minute of turning engine.
m = number of minutes required for one revolution of the main engine crank shaft.

There is no fixed relation between the value of $r\,m$ and the indicated horsepower of the engine. But, roughly speaking, for engines of 1,000 indicated horsepower, $r\,m = 1{,}000$; for engines of 3,000 to 5,000 indicated horsepower, $r\,m = 2{,}000$; for engines of 8,000 to 10,000 indicated horsepower, $r\,m = 3{,}000$.

In order that the large worm wheel may be removed without disturbing anything else, it is usual to make it in two parts, so the number of teeth on this wheel must be even. The diameter of the wheel will be limited by the height of the crank shaft above the foundation. It will be placed as close to a bearing as possible, and it will be found that the diameter of the pitch circle of the wheel cannot be much more than 1.5 times the stroke of the main engine without making it difficult to have access to the holding-down bolts in that neighborhood. The diameter will usually be from 1.1 to 1.5 times the stroke of the main engine.

For practical reasons it is not advisable to use a pitch of less than 1.75 inches upon the small worm wheel, and the pitch is usually from 1.75 to 2.25 inches. The pitch used on the large worm wheel is usually from 2.25 to 3.5 inches.

The proportions of the teeth on the worms and wheels should be about as follows:

Length of teeth = .65 pitch.
Face of teeth = .3 pitch.
Flank of teeth = .35 pitch.
Thickness of teeth at pitch circle = .48 pitch.
Breadth of teeth at root of worm wheels = 2 to 2.5 pitch, or such that the arc of contact between worm and wheel is about 60 degrees.
Least number of teeth on small worm wheel = 25 to 30.

When necessary, the thickness of the teeth of the worm wheel at the pitch circle can be made more than .48 pitch if the worm is made of a stronger material than the wheel.

The size of the teeth cannot be determined until the power which they are to transmit is known. The size of the turning engine cylinder, or cylinders, will depend upon the initial friction of the engine, the efficiency of the transmission gear, and the pressure at which the turning engine takes steam. The turning engine takes steam from the auxiliary steam line, and its pressure may be anywhere from 50 to 100 pounds per square inch.

FRICTIONAL RESISTANCE TO BE OVERCOME.

The power which the turning engine delivers to the crank shaft must be sufficient to start the engine from a state of rest. The frictional resistance to be overcome cannot be taken to be the same as the so-called initial friction determined from engine trials where the engine is run at as low speeds as possible, and the curve of initial friction is continued to the point of zero revolutions. It is well known that for most substances the coefficient of friction is larger in starting from a state of rest than when in motion. The piston speed in these tests for initial friction seldom gets below 200 to 250 feet per minute. When the turning engine is in operation, however, the main engine turns over only once in from five to ten minutes. It is probable, also, that the bearings and piston rods will not be as well oiled at this time as when the engine is under steam, and the friction of the piston rings will be greater, as they have not the lubrication that the condensed steam on the cylinder walls affords. So the initial friction must be multiplied by the ratio that the coefficient of friction from a state of rest bears to the coefficient of friction of motion, and also by a factor to allow for the worst condition of bearings and cylinder walls.

Experiments made by Professor Thurston show that with a cast iron journal in a steel bearing under a pressure of 50 pounds per square inch, and lubricated with lard oil, the coefficient of rest was .07, while when moving at a speed of 150 feet per minute the coefficient was .02. In experiments made

by Mr. Wilfred Lewis, reported in the *Proceedings* of the A. S. M. E., vol. 7, p. 273, the coefficient of friction between the teeth of gears was found to vary, as shown in the following table:

Velocity of sliding feet per minute—	3.15	5.24	10.5	21	52.5	105	210
Coefficient of friction—	.095	.088	.074	.059	.038	.026	.020

When these are plotted, the curve gives the coefficient of friction for a velocity of 0 feet per minute as .108. This makes the coefficient of friction at 0 velocity about 4.5 times that at 150 feet per minute. We seem warranted, then, in assuming that the frictional resistance that must be overcome in an engine which is barely moving will be about four times as great as the initial friction of the engine at the piston speed at which tests are usually made. We will assume, also, that the condition of the bearings, bearing surfaces and cylinder walls at the time the turning engine is used may be such as to increase the work of the engine by 50 percent.

The average initial friction is given by Taylor as being of such an amount as to require 2 pounds mean effective pressure upon the area of the low-pressure piston to overcome it. Blechynden gives from 1.5 to 1.75 pounds mean effective pressure over the area of all the pistons as the force necessary. With the ordinary ratio of cylinder areas this gives from 2.5 to 2.75 pounds mean effective pressure referred to the low-pressure cylinder. The analysis of the *Yorktown* trial gave 1.6 pounds mean effective pressure referred to the low-pressure cylinder as the amount absorbed by initial friction; in the *Kearsarge* it was 1.95 pounds, and in the *Massachusetts* 1.5 pounds.

All things considered, it would seem wise to assume that the mean referred pressure necessary to overcome the initial friction will vary from 2 pounds in naval and other lightly-built engines, where the parts are small relative to the power developed, to 2.5 pounds in the ordinary type of triple engines for merchant ships, and up to 3 pounds for six-cylinder quadruple engines.

EFFICIENCY OF WORM GEARING.

The efficiency of worm gearing varies considerably, depending upon the care taken in its design. Of course, as much care need not be taken in the case of gears for a turning engine, which is used but seldom, and then only for a few minutes at a time, as would be necessary in the case of gears for machine tools. Nevertheless, it is well to bear in mind the principles upon which good design depends. First, the angle of the thread should be as large as possible up to 30 degrees or more for worm gearing, where the maximum efficiency is obtained. With spiral gears the maximum efficiency occurs at an angle of about 45 degrees, but the shafts are not at right angles, so there is not as much side thrust upon the spiral gears as there would be in the case of a worm and wheel with this angle of thread. In order to get these large angles it is customary to use double, triple and quadruple threads. Single threads are always used in turning gears, so the thread angle will not be greater than 9 degrees or 10 degrees, and is more often less than 7 degrees.

Second, the efficiency increases with the velocity at the pitch circle of the worm up to a speed of about 250 feet per minute.

Third, in order to prevent cutting and keep the worm cool, the thrust upon the teeth should decrease as the velocity at the pitch circle increases.

Fig. 3 gives the results of experiments made by Mr. Lewis for William Sellers Company. These curves seem to be in accord with the results obtained from practice (see *Worm and Spiral Gearing*, by F. A. Halsey). These curves show the advantage of using large pitch angles. The efficiencies shown by Fig. 3 can be obtained if the worm is run in an oil bath, and if some care is taken in the design of the thrust bearing for the worm.

Fig. 4 shows the results of tests by Prof. Thurston upon three worms. In the one marked "collar," the thrust was taken by the end of the shaft; in the one marked "button," it was taken by the point of a set screw; in the one marked "roller," it was taken by ball bearings. The lower curve represents the conditions that one is likely to meet in the case of worms for

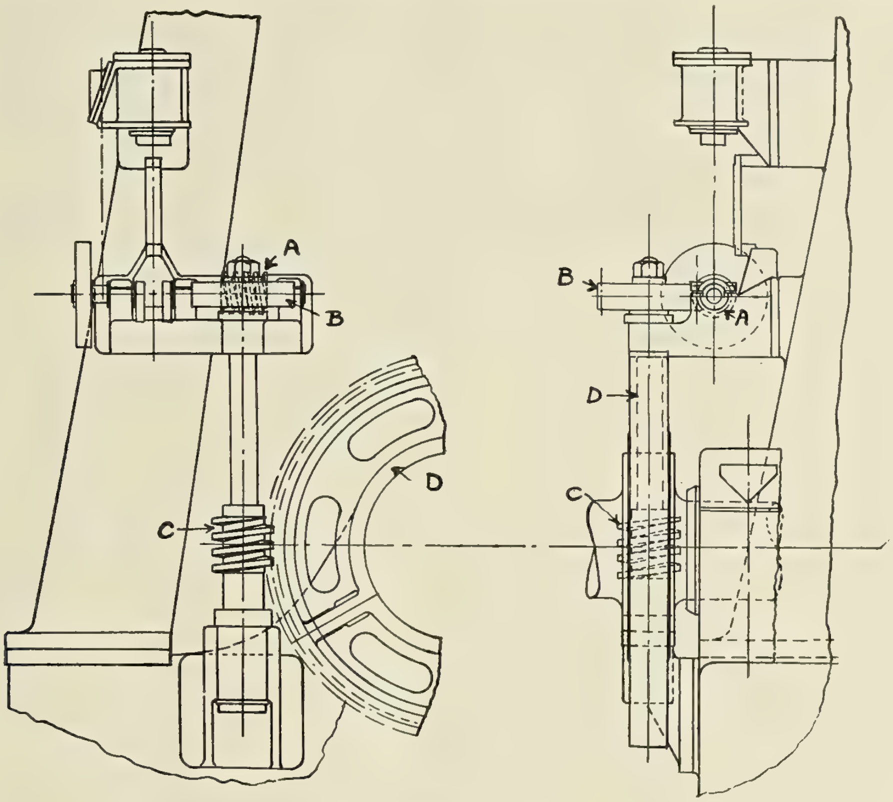


FIG. 2.

turning gears, so it would appear that an efficiency of .4 is about all that will usually be obtained. The lost work, .6 of the total work, will be used up in overcoming friction between the teeth, friction in the thrust bearing of the worm, and friction in the bearing of the worm wheel due to the force acting upon the teeth, at the pitch circle and to the side thrust of the worm. We will assume that the loss in each of the above places mentioned is .2 of the total power driving the worm. In figuring the teeth, then, we shall assume that .6 of the power driving the worm passes through them.

Experiments have been made to determine the relation between the speed at the pitch line of the worm and the force acting normal to the face of the teeth when cutting begins.

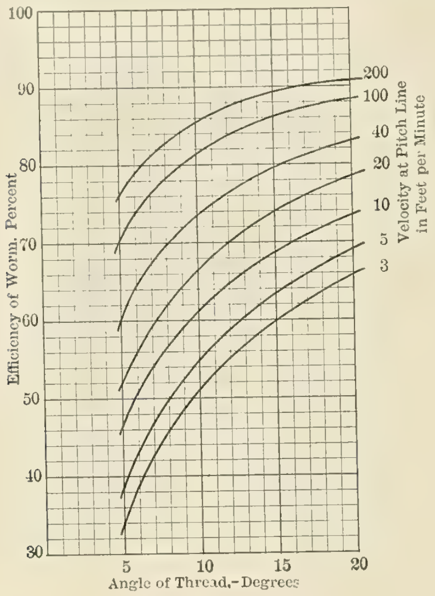


FIG. 3.

Lewis found that with a velocity of sliding of 306 feet per minute, a force of 5,558 pounds produced no cutting and no change in efficiency. With a speed of 360 feet per minute and a force of 4,837 pounds, cutting commenced after running six minutes. With a velocity of 400 feet per minute and a force of 3,481 pounds, cutting commenced after three minutes. The products of these quantities are as follows:

Velocity of sliding, feet per minute	306	360	400
Force × velocity	1,700,748	1,741,320	1,392,400

The experiments made by C. Bach and E. Roser, republished in the *American Machinist*, July 16 and 23, 1903, show smaller values of "force × velocity," but the curves given show that the value of this product increases as the velocity decreases.

The mechanical efficiency of the turning engine will probably be not less than .8, and if the cut-off in the cylinder is about .7 of the stroke the mean effective pressure will be about .75 of the initial pressure absolute. The turning engine takes steam from the auxiliary steam line, where the pressure will probably not be more than 100 pounds, and very often it will be less than that. It is advisable to put in a large enough cylinder so that the engine will run with an initial pressure in the cylinder of 50 pounds gage, or 65 pounds absolute. The stroke of the turning engine is usually from 6 to 8 inches, and the diameter also is usually within this range. When the conditions are such as to call for more than 8 inches diameter, it is advisable to use two cylinders.

Fig. 3 shows that the efficiency of worm gearing increases as the pitch angle becomes larger. In order that the pitch angle of the worm may be as large as possible, it is best to keep the diameter as small as possible. If the small worm is

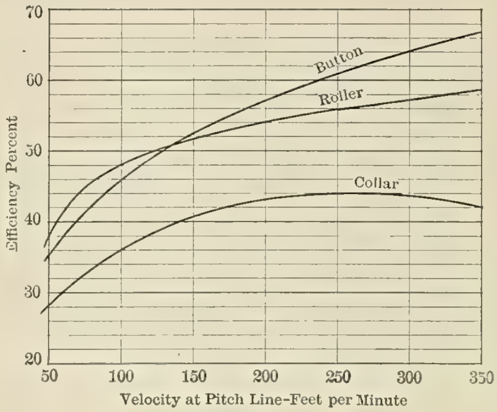


FIG. 4.

cut out of the turning engine crank shaft forging, the diameter of its pitch cylinder can be about 2.5 times the pitch of the teeth. If it is a separate piece keyed to the shaft, the pitch cylinder will have a diameter of about 3 times the pitch of the teeth, in order that the thickness of metal below the root of the thread may be from .5 to .6 times the pitch of the teeth. The length of the worm should be from 3 to 4 times the pitch of the teeth.

If all of our assumptions are correct, we find that the frictional work to be overcome in one revolution of the engine is

$$\frac{\pi D^2}{4} \times MEP_f \times f \times 2S \times g \qquad (2)$$

Where D = diameter of low-pressure cylinder of main engine in inches.

MEP_f = frictional mean effective pressure referred to the low-pressure cylinder.
= 2 for naval and other light engines.
= 2.5 for engines of merchant ships.
= 3 for six-cylinder quadruple engines.

f = ratio between coefficients of friction of rest and motion = 4.

S = stroke of main engine in inches.

g = coefficient to allow for worst condition of bearings and surfaces = 1.5.

(*To be continued.*)

Combination Reciprocating Engine and Turbine-Driven Ships Show High Efficiency.

The White Star liner *Laurentic*, built by Harland & Wolff, Belfast, for the Canadian trade, is the second large steamship equipped with a combination of reciprocating engines and turbines for propulsion. She is propelled by three screws, the two outboard screws being driven by four-cylinder, triple-expansion engines, and the center screw by a single low-pressure Parsons turbine. Steam is supplied at a pressure of 200 pounds per square inch, and is passed first through the reciprocating engines, where it is expanded down to a pressure of from 14 to 17 pounds per square inch absolute; then it is used in the low-pressure turbine, being exhausted finally into the condenser, where a very low vacuum is maintained. The propelling machinery was designed to develop 10,000 horsepower, to give the ship a speed of 15 knots. On the trial trip, however, 12,000 horsepower was developed, and a speed of 17½ knots attained. It is reported that the coal consumption per indicated horsepower per hour was 1.1 pounds, and that the steam consumption per indicated horsepower per hour was 11 pounds. These results bear out the claims for economy made for this system of propulsion by the builders of the New Zealand liner *Otaki*.

DUTCH MARINE SUCTION-GAS PLANTS.

BY F. MULLER VAN BRAKEL.

For the small installations to which the use of producer gas is limited to-day, it is of the first importance that they can be operated with non-professional attendance. The skipper of a motor barge, often a man who formerly owned a sailing vessel and consequently not at all familiar with engines, should be able to manage the whole plant himself. He should remain at the rudder when under way, leaving the firing and oiling to a boy or a deck hand, and only when in harbor should he have to look after the engine, clean it, and keep it in good condition. A power plant which works nicely and economically with an experienced engineer in charge may be uneconomical for the owner of the ship because of the salary of that engineer. On the other hand, with non-professional attendance it may give no end of trouble and even be less economical. Experiments made by technical men are therefore not sufficient in this case, however valuable they may be for the operator of a generator plant and motor.

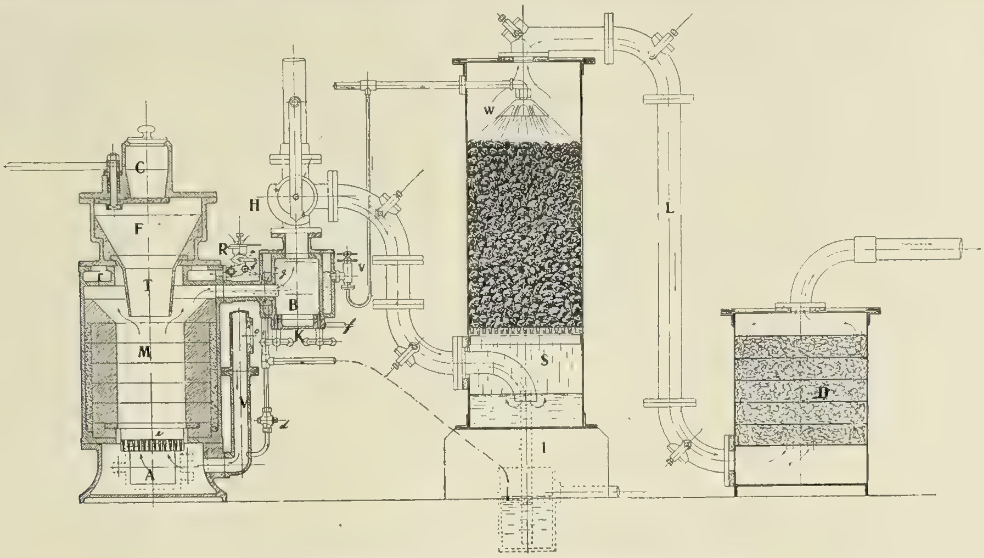


FIG. 1.—DIAGRAM OF DUTCH MARINE SUCTION-GAS PLANTS.

To judge of the advisability of placing a producer-gas installation in a small vessel, the experience of non-professional skippers is of great, or rather of the first importance. Messrs. E. J. Smit & Son, Hoogezand, Groningen, Netherlands, have built since 1902 a good many ships with suction-gas plants, for different owners, and with many of these they have remained in touch, for varying reasons. Some owners called to have different troubles removed or to be told the unnecessary sources of them; others, when passing on their regular trips, to tell of their satisfaction, mentioning the profits made and the actual working costs. These, too, occasionally told about troubles experienced, which had been removed by skippers themselves after some seeking and trying, or which disappeared in an unexplained way—as engine troubles sometimes do when the engine is handled by inexperienced men. It was this information that made it possible to produce an engine that could be managed by non-technical men. The construction and management, the troubles experienced, the necessary room, and the weights of this installation are described in the following, while a discussion of the costs as compared with steam and oil engines will follow in a later issue.

DESCRIPTION OF THE PRODUCER-GAS INSTALLATION.

The principal parts of the producer installation are shown in Fig. 1. *M* is the cast iron producer, which for bigger installations is made of ¼-inch plate. *B* is the ash catcher, *S* the scrubber, *D* the last cleaner, filled with wood shavings. Air and steam are introduced under the producer grate *e*, and are pulled by the suction of the motor through the layers of burning coal. There the coal is first burned to carbonic acid, but higher up in the producer it is mostly reduced to carbonic oxide. The necessary oxygen is furnished by the air and by the steam, leaving the hydrogen as a desirable element of the gas mixture. The air enters through the regulating cock *R*; the water through the valve *v* into the water jacket of the ash catcher *B*, where it is heated. The water level in the jacket can never be higher than the opening of the overflow *g*, from which the water is seen dripping into the funnel shown in dotted lines. This funnel leads to the water vessel *l*; part of the water may be led to the ashpit through cock for wetting the ashes or to bring more hydrogen into the gas mixture. From the jacket of *B* the water passes through the small tube *C* (where a cock allows regulation) to the body of cock *R*. Steam that might be formed in the jacket can proceed to *R* through the small tube *a*. In the body of cock *R* a sight-hole allows observation of the quantity of water that is seen as small jets, corresponding to the intermittent suction-action

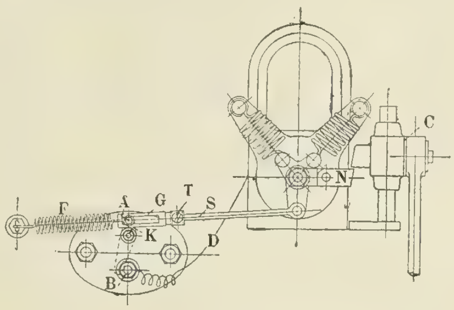


FIG. 2.

of the motor. In the ring *r* the water is evaporated and passes with the air through the down-tube *V* to the ashpit.

Thus the principal points to be observed when the engine is just started are:

1. The water dripping from *g* into the funnel—to be regulated by the water valve *v*.

2. The small water jets seen through the sight hole in air cock *R*—to be regulated by the cock in tube *C*, and by the air cock itself. For diminishing the opening for air means a stronger pull exerted on the water.

3. If steam is seen coming out of *g*, the cock in tube *a* must be opened, to lead the steam formed in the water jacket to the air cock and evaporator ring.

From the ash catcher the gas passes through a 3-way cock *H*, which leads to the atmosphere or to the scrubber-bottom.

Fig. 3 shows another arrangement of the piping between ash catcher and scrubber, which has advantages. The end of the gas pipe dips about ⅞ inch into the water under the scrubber, in this way preventing the gas from return from scrubber to producer. The water level under the scrubber is kept constant by an overflow leading to the water vessel *l*. The vertical

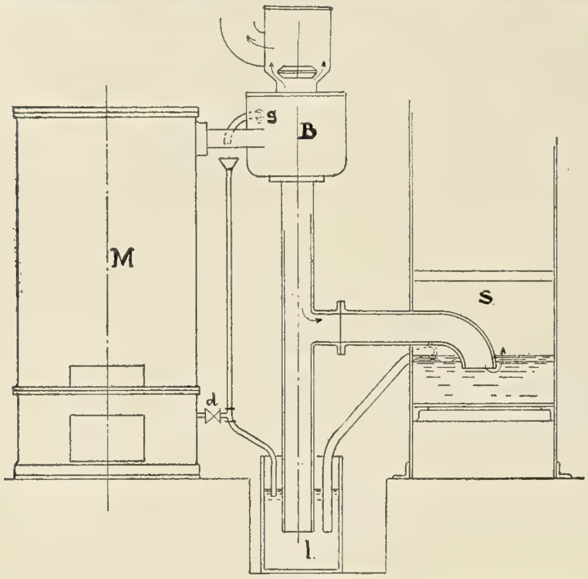


FIG. 3.

distance between the water levels in scrubber and water vessel should be at least 14 inches. When it is smaller the water in the water vessel might be sucked up into the scrubber, thereby augmenting the water resistance. The scrubber is filled with coke in pieces of about 2¼ inches by 4 inches; while water is constantly dripping through the whole column.

The last cleaner consists of a plate cylinder with six thin circular plates in it, between which the wood shavings are

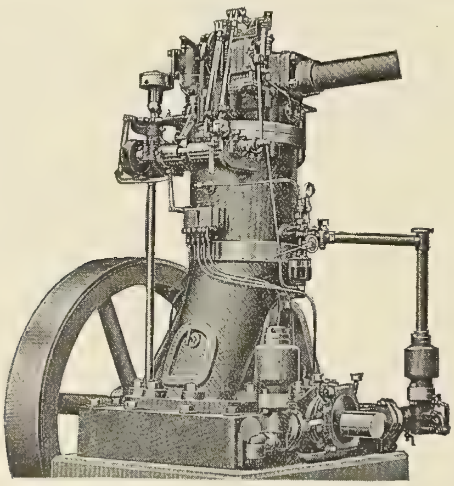


FIG. 4.

kept. The condensation water should be left off every night.

THE MOTOR.

The gas mixture on leaving the last cleaner is composed as follows:

CO	28 percent.
H	7 percent.
CO_2	5 percent.
CH_4	2 percent.
N	58 percent.

It will not burn without the addition of air. This is added in a mixing vessel attached to the motor, in the proportion of 1:1.

The motor, Fig. 4, is a vertical four-cycle engine, mounted on a low under-frame. The *A* frame is cast in one piece with the cylinder, in which a liner is fitted. The legs of the frame have doors for getting at the crank shaft and connecting rod. In the separate cylinder head the inlet and outlet valves are mounted vertically, both of them kept shut by springs and opened by levers driven by cams on a horizontal cam shaft, which makes half the revolutions of the crank shaft. The regulator works a throttle valve, regulating the passage for the air and gas mixture.* This gives at all speeds well-formed diagrams, though differing in size (Fig. 5).

The ignition is electro-magnetic, details of which are shown in Figs. 2 and 6. The spark-drawer, *A K B*, when at rest, touches the end of the pin *P*, which takes the current from *D*.

FIG. 5.

The part *C*, moving downward, takes *N* with it, thereby pushing the rods to the left, leaving *A* free, however, because it slides in slot *G*. When *C* releases *N*, rod *S* springs back to the right, taking *A* with it for a very short moment, thus breaking the current at *B* and giving the spark.

On the forward end of the crank shaft an eccentric is fitted, driving a cooling-water pump and a bilge pump, mounted opposite each other. The after end of the crank shaft bears the flywheel with the clutch inside.

STARTING.

For starting a hand-operated fan is used, placed on the tube *V* at *c*. It blows the outer air under the grate, through the producer, ash catcher and 3-way cock *H* to the atmosphere. The producer is kindled with wood and a few loads of coal, which are put into the producer through the lock *C*. While

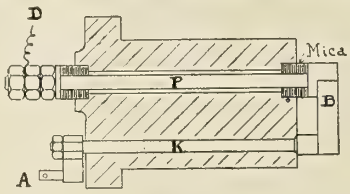


FIG. 6.

the fan blows the fire the air-and-water cocks remain shut and the 3-way cock *H* leads to the atmosphere. After some ten minutes more coal is locked into the producer till it is filled to the under side of the funnel *T*. The fan is kept blowing till at last the greater part of the coal is glowing well, then two more loads of coal are put on and the 3-way cock turned to the motor. Somewhere in the piping between the last cleaner and the motor a gas-trying cock is fitted, and here the gas is now tried. It should burn with a dull orange flame, that is not easily blown out. The motor is started by turning the flywheel by hand and then the fan is stopped. The producer now only gets air through the body of the fan, but the air-and-water cocks are opened as soon as the motor is going well, the valve between fan and air pipe *V* being shut next. After some thirty minutes the steam cock in tube *a* is opened.

After stopping for some time the motor is started in the same way. When the gas is tried it burns with a blue flame, showing the presence of hydrogen in the mixture.

PERIODICAL CLEANINGS.

The inside of the producer should be cleaned twice a week. The grate every two hours. This is done through the bottom

* Fig. 4 shows an old form of regulator regulating the quantity of gas only.

door after wetting the ashes and poking through the upper door.

The scrubber coke should be renewed once a year. It may then be burned in the producer, mixed up in the anthracite in the proportion of 1:4, after being ground to small pieces.

The wood shavings in the last cleaner must be renewed twice yearly, the piping being cleaned at the same time.

TROUBLES.

Motors that never give any trouble are to be found only in advertisements—in fact, all those motors have that desirable quality. In practice, on the contrary, troubles are rather frequent, as most motor men will know. It should be acknowledged, however, that most of the troubles are not so much the fault of the motor, or its manufacturer, as of the man who handles it. Motors that are well beyond the experimental stage never need to trouble their owners. But here comes in the difference between a sensitive and an easy plant. The steam engine is an example of an easy plant. Many things may be said against it, but it *always goes* when the steam valve is opened. On the other side stands the suction-gas installation as a typical sensitive plant. It is sometimes claimed for marine gas plants that: "Any man who can take proper care of an internal combustion engine, can, without any difficulty whatever, manage the producer-gas plant." (INTERNATIONAL MARINE ENGINEERING, Volume XIV, page 313.) This may be so, at any rate it will seem so, but it cannot be said of the plant described here. There are too many points where something may go amiss; and a man to whom the installation is new cannot at once master the whole plant. But it can be claimed that *every* man, those who never before handled an engine included, can *learn* the management in a short time. This has been proved in many instances. During that time, however, there will be troubles—with the usual bad temper and bad names for the maker. They all make themselves known by the stopping of the motor. The sources of trouble may be divided into two kinds: those originating in the producer plant; those originating in the motor itself. Of the former the following are the most common:

1. Insufficient Gas when Starting.—Some hasty skippers only fill part of the producer when starting, blow the fire through till it gives good gas and then immediately start the motor. As a consequence, the motor stops after a few minutes for want of gas. The same thing may happen after stopping an hour or more. It is then often tried to keep the motor going by filling the producer to the funnel, but this has no effect then; it is necessary first to clean the grate and then blow the fire by means of the fan till it is blowing well again. And only then, and not before, the producer may be filled.

2. Bad Quality of Gas.—There may be lack of hydrogen, by bad regulating or by some water pipe being stopped up; or there may be an excess of air, by leaks in the piping or by cracks in the stone covering of the producer. Or, when encountering heavy weather at sea, the water vessel *l* may be emptied by the rolling of the ship, thereby admitting air under the scrubber. This can be avoided by a piece of wood floating on the water or by a cover over the water vessel.

3. No Gas while Working.—When there is a good fire the lack of gas always originates in too much piping resistance. Either the pipe under the scrubber dips too deeply into the water, or the wood shavings in the last cleaner are packed too stiffly. The first is caused by a rising of the water level under the scrubber, for which there may be three causes:

a. The producer coal bakes, which augments the resistance for air and steam. As a consequence there is less pressure under the scrubber and the water from the water vessel is pushed up by the atmosphere.

b. The water vessel *l* is placed too high.

c. The water level in the water vessel is too high.

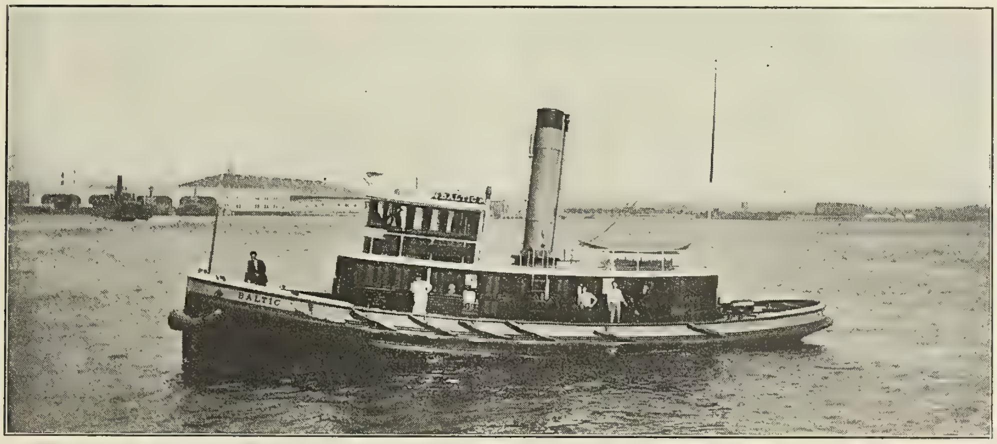
The most common troubles originating in the motor are as follows:

1. Lack of Compression.—This is to be tried by turning the flywheel by hand and observing the resistance during the compression stroke; the causes may be: leaks in the packing between the cylinder and cylinder head, leaks of the valves, leaks of the piston rings.

2. Lack of Ignition.—This is mostly caused by water entering the cylinder. Sometimes cooling water is admitted through the packing between cylinder and cylinder head. But mostly the insulation of pin *P* (Fig. 6) is disturbed by moisture, tar or dirt settling on or between the mica rings.

The ignition can be tried in two ways: by feeling it with the finger on *P*, or by looking at it through a sight hole.

(To be continued.)



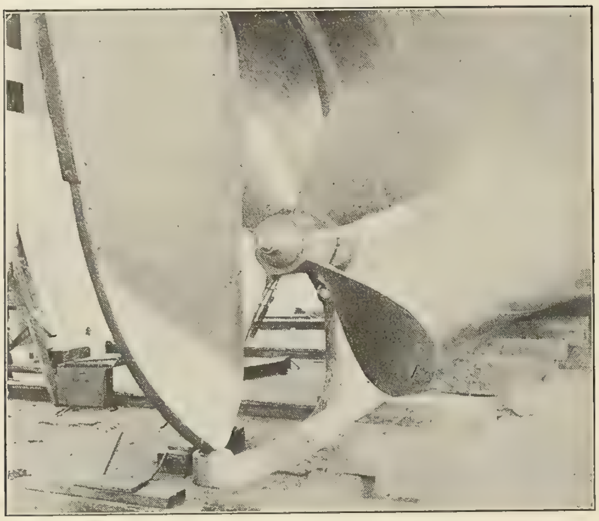
HARBOR TUG BALTIC.

INDICATOR DIAGRAMS FROM A HARBOR TUG

BY CHARLES S. LINCH.

Indicator diagrams taken from single cylinder engines of harbor tug boats are very scarce and the writer believes that the diagrams shown herewith are the first ever taken from a Neafie & Levy tug of this size. The engine is a single-cylinder non-condensing vertical engine, having a diameter of 16 inches and a stroke of 16 inches. The clearance at the top of the cylinder is 11/16 inch and at the bottom 13/16 inch. The lead of the main valve at the top is 1/16 inch ahead and ⅛ inch astern; at the bottom it is ⅛ inch ahead and 3/16 inch astern.

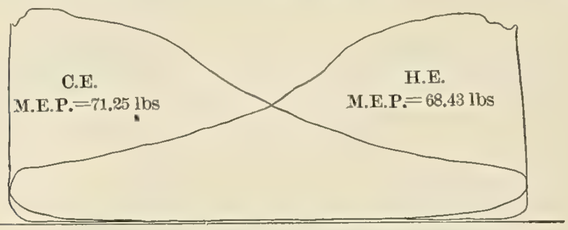
Recently the writer was engaged in designing a new propeller for the tug, and, as a new cylinder was fitted on the engine at the same time, it was drilled and tapped for indicator pipes in order that accurate data regarding the performance



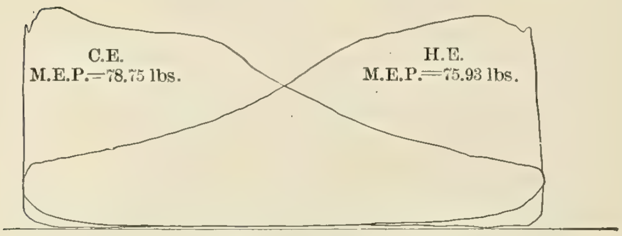
NEW PROPELLER FITTED ON THE BALTIC.

of the new propeller could be obtained. It was desired in making the changes to secure a propeller which would be a more efficient towing wheel and also a more efficient backing wheel. The revolutions were to be reduced from 165 turns when running free to not more than 135 when running free at a steam pressure of 120 pounds per square-inch gage. When cutting off at 7 inches, the revolutions at 120 pounds of steam were to be about 120.

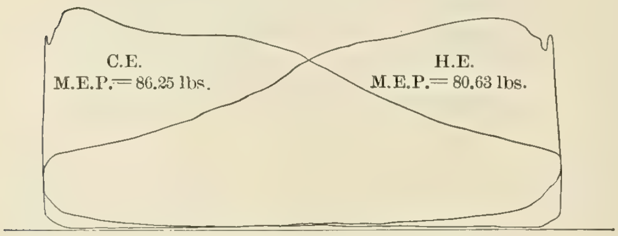
When the new propeller was designed, the power was of necessity computed, since no indicator diagrams were available. After the wheel had been fitted, and the new cylinder installed, a series of indicator cards was taken throughout the entire range of cut-off. It will be remembered that this type of engine is fitted with a Meyer cut-off valve. A set of these indicator diagrams at various cut-offs are shown herewith, together with given and computed data. These diagrams are worthy of close study, and it will be noted that the same characteristics are apparent throughout the whole range of cut-off.



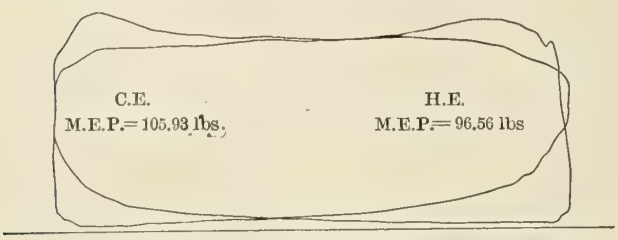
INDICATOR CARD TAKEN WITH 6-INCH CUT-OFF.



INDICATOR CARD TAKEN WITH 7-INCH CUT-OFF.



INDICATOR CARD TAKEN WITH 8-INCH CUT-OFF.



INDICATOR CARD TAKEN WITH VALVES AT FULL TRAVEL.

GRAPHICAL SOLUTION OF THRUST-BEARING PROBLEMS.

BY GEORGE E. BARRETT.

The tendency of the engineers of to-day is towards the adoption of the graphical solution of standard problems, which is due to the rapidity and accuracy of obtaining the results; this is particularly prominent where the formula has more than three variables. Generally, standard formulas are so written as to require a certain amount of rearranging in order to solve for some unknown part, but when once this equation has been plotted any one of its variables can easily be determined for any particular case.

In Fig. 1 the following variables, horsepower, knots, pressure per square inch, number, and outside diameter of the thrust bearing of horseshoe bearings and their centers of gravity, have been plotted and so arranged as to permit of easy solution of any one variable with the others being known or assumed. The general formula

$$A = \frac{217\ H.\ P.}{K\ p\ N}$$

was used, in which

A = area of one horseshoe bearing.
K = the speed of the ship in knots.
p = the allowable pressure on the bearings per square inch of surface.
N = the number of horseshoe bearings.

As can be seen, this formula was deduced from Seaton's well-known expression for the mean thrust on the thrust bearings, which, if divided by pN will give the area of one bearing.

The range of p from 20 to 60 pounds per square inch in increments of 5 pounds should be sufficient for practical cases, though finer readings can be easily obtained within 1 or 2 pounds. This applies equally as well to the curve for knots and inside diameters of the horseshoe bearings.

The diameter curves were plotted from the following formula:

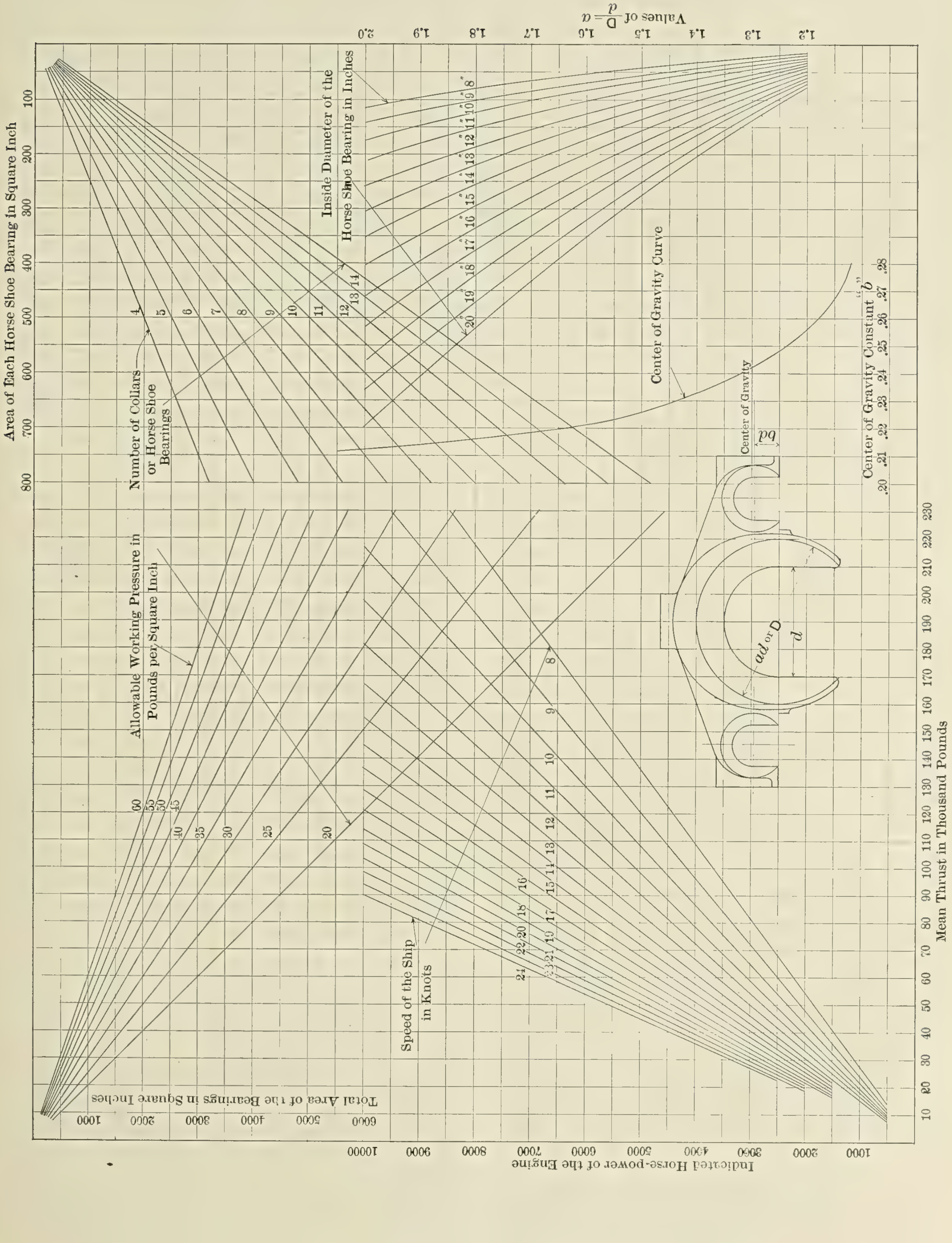
$$A = a^2 r^2 \pi - \left\{ \frac{r^2 \pi}{2} + \frac{a^2 r^2 \pi\ 2\ \theta}{360} + r^2 \sqrt{a^2 - 1} \right\}$$

which can be reduced to the following simpler expression:

$$A = r^2 \left\{ \pi \left[a^2 \left(1 - \frac{\theta}{180} \right) - \frac{1}{2} \right] - \sqrt{a^2 - 1} \right\}$$

In which

A = the area of the horseshoe bearing.
a = the ratio of the outside to the inside diameter of the bearing.
θ = the angle as shown in Fig. 2.



Area of Each Horse Shoe Bearing in Square Inch
Values of $\frac{D}{d} = a$
Inside Diameter of the Horse Shoe Bearing in Inches
Number of Collars or Horse Shoe Bearings
Center of Gravity Curve
Center of Gravity
Center of Gravity Constant "b"
Allowable Working Pressure in Pounds per Square Inch
Speed of the Ship in Knots
Total Area of the Bearings in Square Inches
Indicated Horse-power of the Engine
Mean Thrust in Thousand Pounds

FIG. 1.

The center of gravity of the bearings was computed from the formula

$$C.\ g. = \frac{r^3\ (a^2 - 1)}{A},$$

which was deduced as follows:

The center of gravity of the sector $A\ O\ B$ from the center line $X\ Y$ is $\dfrac{4 R r}{3 \times \text{arc}\ A\ B}$. Arc $A\ B = \dfrac{R\ \pi\ \Theta}{90}$. The moment of the sector about the center line $X\ Y$ is:

$$\frac{R^2\ \pi\ \Theta}{180} \times \frac{4\ R\ r}{\dfrac{3\ R\ \pi\ \Theta}{90}} = \frac{4\ R^2\ \pi}{6}.$$

The moment of the triangles $A\ D\ O$ and $B\ O\ C$ about the center line $X\ Y$ equals

$$\frac{1}{3}\ r\ \sqrt{a^2 - 1} \times r^2\ \sqrt{a^2 - 1} = \frac{1}{3}\ r^3\ (a^2 - 1).$$

The moment of the semi-circular section $D\ E\ C$ equals

$$\frac{1}{2}\ r^2\ \pi \times .4244\ r = .2122\ r^3\ \pi.$$

The center of gravity of the horseshoe bearing will be

$$C.\ g. = \frac{.2122\ a^3\ r^3\ \pi - .2122\ r^3\ \pi - .2122\ a^3\ r^3\ \pi + a^3\ r^3 - {}^1/_3\ r^3}{\text{Area of the shoe}}$$

$$= \frac{r\ (a^2\ r^2 - r^2)}{A} = \frac{r^3\ (a^2 - 1)}{A}$$

This center of gravity formula was further arranged so that multipliers, which have been termed b, of the inside diameter of the horseshoe bearing could be easily obtained for the different values of a. This can be readily proved if desired by assuming fixed values of a in the area and center of gravity formulas, which will reduce the center of gravity formula to the simple expression bd, b being a constant for all bearings having the assumed value of a for the ratio of the inside to the outside diameter.

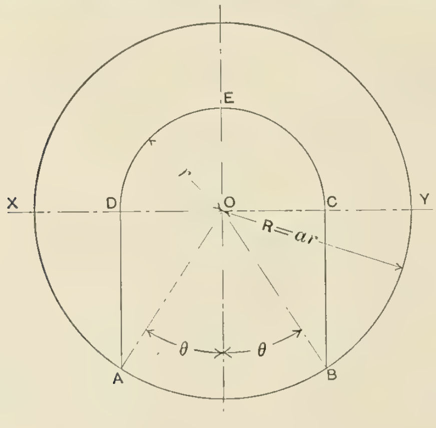


FIG. 2.

The curves in Fig. 1 have been plotted so that the mean thrust for any horsepower up to 10,000 and knots from 8 to 22 can be read; also the area of each bearing and the total area of all the bearings can be obtained.

The following examples will be used to explain the practical uses of the curves. What should be the outside diameter of the horseshoe bearings for the following conditions? Indicated horsepower, 5,000; knots, 16; allowable pressure per square inch, 35 pounds; 10 collars; inside diameter of the horseshoe bearings, 17 inches. Enter the scale for the horsepower at 5,000, and run horizontally over to the curve marked 17 for the speed in knots, then vertically upward to the curve of pressures marked 35, and over horizontally to the number of bearings curve marked 10, down vertically to the inside diameter curve marked 17, then over horizontally to the a scale. Answer, $17 \times 1.47 = 25$ inches diameter. The center of gravity of this bearing will be $17 \times .228 = 3.88$ inches above the center line. The mean thrust is 64,000 pounds and the area of each horseshoe bearing is 185 square inches.

How many collars should a thrust shaft have for the following conditions? Two thousand five hundred horsepower; 14 knots; about 30 pounds working pressure; inside diameter of the horseshoe bearing 15 inches; $a = 1.65$. Enter the scale for the horsepower and continue as explained above until the curve for the number of collars is reached. Enter the a scale at 1.65, and run over horizontally to the diameter curve marked 15, then up until the line from the pressure curve is intersected, which locates a point that falls on the curve for 6 collars. The center of gravity of this bearing will be $15 \times .22 = 3.3$ inches; above the center line, say, 3 5/16 inches.

What is the area of a horseshoe bearing that has an inside diameter 16 inches and an outside diameter 24¼ inches? $a = \dfrac{24\frac{1}{4}}{16} = 1.52$. Enter the a scale at 1.52, then over horizontally to the 16-inch diameter curve and up vertically to the area scale. Answer, 185 square inches.

A REMARKABLE SALVAGE JOB.

On May 13 the barge *S. O. Co. No. 91*, loaded with a full load of fuel oil, in tow of steamship *Maverick*, struck the bar at the mouth of the Columbia River. A heavy surf was running at the time, which broke the forward port sea chest and also the oil suction between the port oil pump and tanks, allowing both sea water and oil to run into the pump room,

FIG. 1.—LOOKING AFT ON THE WRECKED BARGE

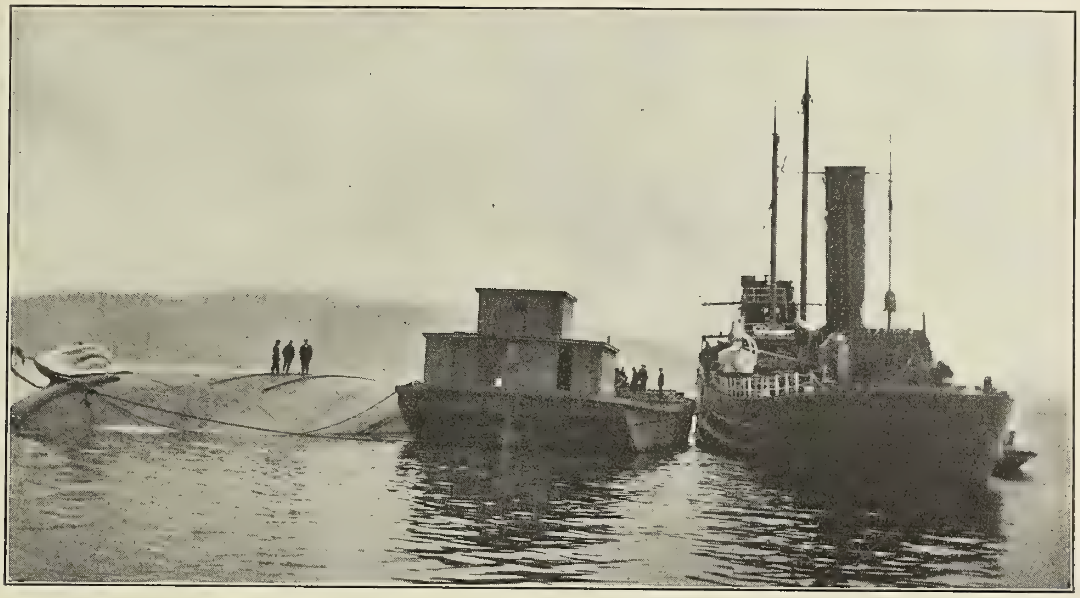


FIG. 2.—BARGE BEFORE PUMPING OUT THE OIL AND WATER.

filling this large compartment and causing the barge to sink forward and roll over on her port side in about 50 feet of water. The barge was 256 feet long with a beam of 42 feet and a depth of 25 feet.

The general opinion was that she could not be saved, but salvage operations were undertaken by Mr. D. E. Ford, marine superintendent of the Standard Oil Company. As there was from 6 to 8 feet of water over the side of the barge at low tide, it was necessary to build a cofferdam of sufficient size to allow a man with a pneumatic hammer to cut holes in the side of the barge in order to fit 6-inch suctions for pumping out the cargo in the starboard compartments. After this work was completed, and the pumps connected up and sufficient oil pumped out, the barge was moved in towards the beach, where there was about 30 feet of water at low tide.

After the barge was hauled in towards the beach a 12-inch centrifugal pump was fitted in the pump room, and when the water and oil were lowered sufficiently in this space temporary connections were made with the cargo pumps, and the oil in the port compartments was pumped into lighters and tank steamers, enabling the righting of the barge to an angle of about 30 degrees, and also permitting the placing of a lighter on the port side of the barge with suction pipes into the port tanks, in order to pump out the balance of the cargo.

Two tripods, one forward and one aft, built of heavy channels and I-beams, were rigged on the starboard side of the barge, and by means of 100-ton tackles the barge was righted on an even keel as the oil was being pumped out of the port tanks.

One of the great difficulties experienced in salving the barge was the fact that the wreckers had to contend with a heavy freshet in the river, which was constantly cutting the sand out from under the barge and allowing her to settle deeper in the sand at the rate of about 1 foot per day. Although the work of salving the barge was planned and carried out by Mr. Ford, a great deal of credit for the success of the undertaking is due to Capt. Bunting and Mr. Hague, both connected with the Standard Oil Company, San Francisco, Cal.

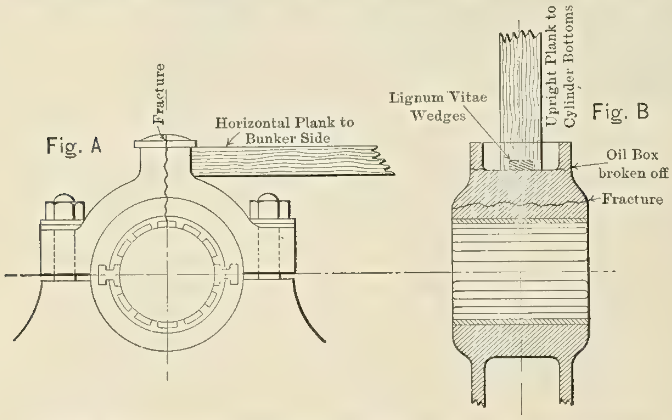
FIG. 3.—BARGE PARTIALLY RIGHTED.

PRACTICAL LETTERS FROM MARINE ENGINEERS.*

Experiences Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

A Critical Forty Minutes.

The experiences of a sea-going engineer very often include times of sudden stress in which every effort of concentrated resource must be exercised in order to advert disaster. An instance of this occurred some time ago in a steamer bound from Galveston to Havre with a large cargo of cotton. The ship was caught in a heavy gale with a high following sea, and those engineers who have experienced a westerly gale will hardly need to be told that a boat under such conditions will run along smoothly and steadily until an unusually large



SKETCH SHOWING FRACTURES IN MAIN BEARING CAPS AND METHOD OF HOLDING THEM IN PLACE.

roller comes along. The boat gets caught on the crest of this wave, and the result is a swept deck or something considerably more serious.

Although careful attention was observed, as the propeller lifted out of water the engines raced heavily before being throttled by the main valve. As a result, in one heavy race the engine carried away three main bearing caps, the fracture extending right through the center of the oil boxes, as indicated in the sketch.

Under the circumstances there was no time for confusion or any attempt to take various opinions as to the best course to adopt. Repairs were effected immediately in the following manner:

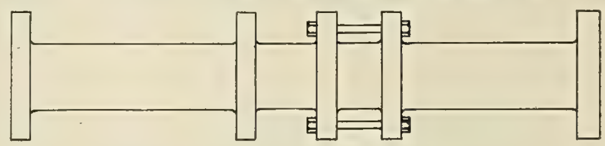
The first step was to knock off the oil boxes flush with the top with a 28-pound hammer. A heavy plank was then fitted to each cap, reaching up to the cylinder bottoms. Over the top end of the plank was tacked a piece of asbestos cloth, in order to protect that end from the heat of the cylinder as much as possible, and in order to press the bearings down firmly wedges were made and driven in under the lower end of the plank and on the top surface of the oil box, as shown in Fig. *B*. These wedges were made of some old lignum vitæ strips which had been preserved from the last time that the stern bush of the vessel had been lined up. These strips were made up into long, thin wedges, which were practically as hard as steel itself. By this means the planks were wedged up firmly and solidly, and enabled the ship to get away, to the great relief of everybody on board. She had lain in the trough of the sea for forty minutes, and lost everything moveable from her decks.

When the engines were got under way again a horizontal plank was fitted between the projecting portions of the oil box which was left and the bunker side, as shown in Fig. *A*, in order to relieve as much as possible the twisting strain on the shaft. The engine was run for a few hours at reduced speed, but after careful watching it was found that the bearings stood all the work which could be put on them, so the engine was pushed up to full speed, and the boat arrived safely at Havre. The surveyor there pronounced the engine perfectly safe to proceed to the Bristol Channel, which was excellent testimony to the efficiency of this hastily rigged-up repair.

Other caps were subsequently obtained from the builders of the engine, who said that in their experience of forty years of commercial life they had never known such an accident to happen before, and, so far as the writer is aware, no similar breakdown has occurred before. It is therefore interesting as showing the very high factor of safety which must be used in the design of such bearing caps, on account of the sudden severe stresses which may be thrown upon them, producing the effect of a heavy blow. At the time of the accident, however, the writer's interest was not centered in the theoretical considerations involved, as his life was never in greater danger than on that occasion. Anson C. Stokes.

Repairing a Broken Thrust Shaft.

In repairing a thrust shaft which broke in between two collars of the thrust bearing, two of the thrust shoes were first removed, and four holes were drilled through the collars by means of a hand ratchet. Through these holes four ¾-inch bolts were fitted, and the shaft was drawn together at the fracture. Fortunately, the fracture was diagonal, so that to



LOCATION OF BOLTS IN BROKEN THRUST SHAFT.

some extent the two halves keyed into one another, assisting the bolts in transmitting the stress. For this reason the ¾-inch bolts, which were the largest size which could be found on board, although very slight indeed for this purpose, were not over stressed, and the repair held out satisfactorily for the homeward run of about 100 miles at reduced speed.

Fred Curtiss.

Broken Air-Pump Links.

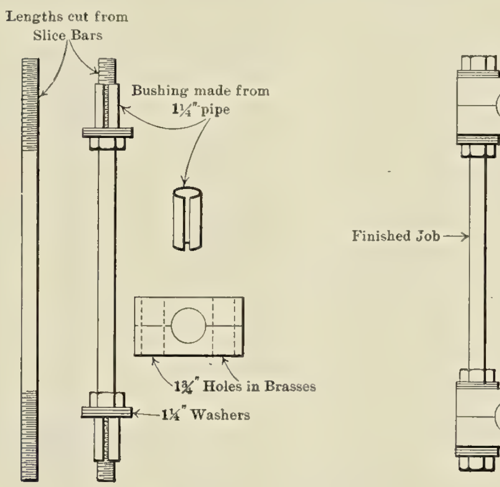
This fracture is seldom met with in practice by the average marine engineer, consequently few would be apt to know the most logical way to effect repairs that are thoroughly serviceable in every respect. A few years ago such an accident happened on board one of the United States navy colliers, which was originally an English tramp steamer of about 7,000 tons displacement and equipped with the English type of engines. The air, feed and bilge pumps were all connected to the air-pump cross-head, and commonly actuated by the low-pressure engine.

The ship came to anchor for a few hours at Punta Arenas,

* These letters are contributed by our readers and paid for at our regular rates.

Strait of Magellan, en route to San Diego, Cal., consequently the entire engine crew were busy packing leaky rods, placing liners under eccentric rods, examining the air-pump valves, etc. It was found necessary to insert a few tin liners in back of the tail-rod guide brasses in order to line it out, as the rod had worn the brasses to such an extent that it had considerable play. As the tail rod was screwed onto the threads of the air-pump rod, which projected through the cross-head, it was essential to block up the bucket before the tail rod was unscrewed. After filing and fitting the brasses and lining out the rod, resulting in a good job, orders were given to clear all "gear," etc., away and have everything ready to start.

In the haste which ensued a block of wood was left in the air pump, and as soon as the engine made its first "turn-over" revolution the links bent over and all four snapped off. This, of course, necessitated a further delay of about four hours; nevertheless, very substantial repairs had to be made. Having



AIR-PUMP LINKS MADE FROM SLICE BARS.

no spare steel bars available for the purpose slice bars had to be cut instead. The broken links were disconnected and measured, and four lengths were cut from the slice bars 3 inches longer to allow for washers, etc., as will be explained later. As the diameter of each slice bar was only 1¼ inches, and that of the broken links 1¾ inches, with threaded ends of the same diameter, it was necessary to cut eight pieces of 1¼-inch pipe, splitting them on one side to fit over the threaded ends and take up the space between the 1¾-inch holes and new 1¼-inch rods in all the brasses, as shown in the sketch. After these were roughly filed, allowing no slack when on the rod and in the brasses, threads were cut on all ends to a distance of about 9 inches.

To take the place of the collars on all the rods, a 1¼-inch nut was run down on the thread and three 1¼-inch iron washers were placed on top, then the brasses were shoved on, and secured together by three more washers and another 1¼-inch nut on each end, as will be seen in the sketch.

This repair job proved very serviceable with the engine running at full speed, and was still in good order at the end of two months, when new rods were made in the shop.

J. W. F.

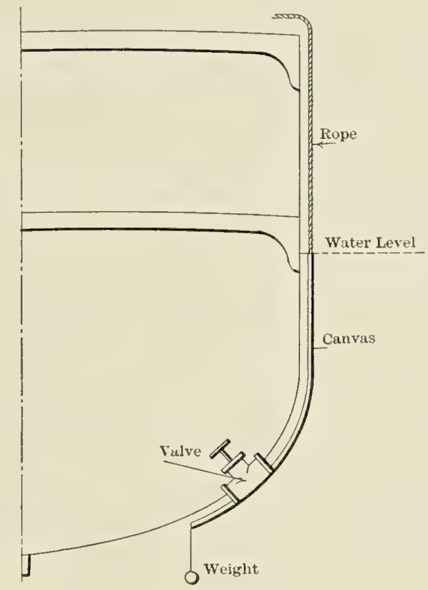
Method of Closing a Large Sea Valve in an Emergency.

We arrived in an English port one night and went below the coal tips to fill up our coal bunkers for a long voyage. The next morning the chief engineer told one of the apprentices to see that the main injection valve on the ship's side (for the port engine) was properly shut, and then to slacken off all the nuts on the main condenser doors and take off the doors preliminary to testing the condenser for any leaky tubes. The first engineer thought he had fully explained the job, and that the apprentice clearly understood what was to be done, so he went into the boiler room to look after the main boilers, which had been opened up for cleaning, leaving the apprentice to carry out the work on the condenser.

In a few minutes we heard a great rush of water in the engine room, and immediately discovered that the apprentice had taken off all the nuts on the main injection valve cover, and that the valve, spindle and cover had been lifted out of place, allowing the sea water to flow into the ship through the full 12-inch opening.

We promptly started all the pumps and called the first engineer, but none of our attempts to plug up the hole was successful. By this time we were up to our knees in water in the stoke-hole, where the donkey boiler was located, and in a few minutes the water would be up to the furnaces. It was necessary to act and to act quickly.

The first officer secured a large piece of awning canvas, and attached a weight to each corner of one end, just heavy enough to sink it. Ropes were attached to the two opposite corners and fastened on deck. The weighted end of the canvas was then dropped over the ship's side in way of the main injection valve. The inrush of water through the valve hole quickly



A BROKEN SEA VALVE EFFECTIVELY CLOSED BY A PIECE OF WEIGHTED CANVAS.

drew the canvas over the hole and completely stopped the inrush of water to the engine room. We then straightened the valve spindle, which had been forced up against an overhead iron beam on the ship's side, and replaced the valve, putting everything back in proper shape. We considered that we were very lucky in that no damage was done by the water either in the stoke-hole or in the engine room. If the ship had been deep in the water with a full cargo it would not have been so easy to fit on the outside canvas.

It seems to me that the first officer deserved great credit for the quick manner in which he decided to try and help his shipmates out of a bad position, and his ingenuity only shows what can be done on board ship when mates and engineers pull together for their employer's benefit.

Some time ago a steamer was sunk in Hong Kong harbor from very nearly the same cause, a mistake having been made by a junior engineer. Donald McColl.

Shanghai, China.

Machining a Stern Tube.

Stern tubes are usually made of cast iron, the construction being as shown in Fig. 1. Such a tube is machined as indicated by the finish marks on the sketch. The first step is to fit bridge center pieces at each end, as shown in Fig. 4. Previous to this, however, the casting should be checked over for size. In placing the tube in the lathe, the flanged end should be placed next the chuck or face plate. The chuck is the handiest for this operation, as it affords a solid drive and supports the weight of the tube during the boring-out operations.

The first operation is to rough-turn the end which goes through the sternpost, and then the small bearing surface next

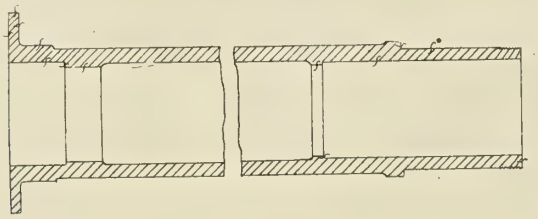


FIG. 1.

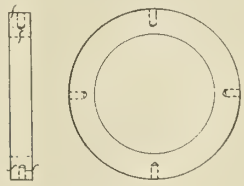


FIG. 2.

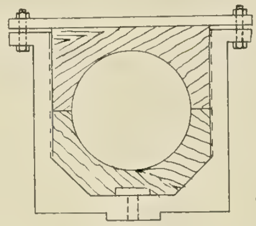


FIG. 3.

the flange at the stuffing-box end; this part fits into the bulkhead. As it is easier to turn the tube to a given size than to bore out the sternpost and bulkhead to gage sizes, these holes are sometimes bored out as closely as possible to drawing size, then gages are made to which the tube is turned.

The distances between the sternpost and the bulkhead are also measured, and the tube machined to suit. This length measurement need not necessarily be very exact, as the flange is not bolted directly to the bulkhead, packing pieces of hardwood being placed between the flange face and the bulkhead. The thickness of these pieces may vary from ½ to 1½ or 2 inches.

The exact length and diameter being obtained, the tube is finished to size and length. At this setting, the inside face of

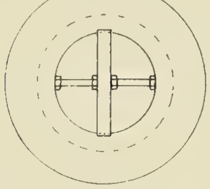


FIG. 4.

FIG. 5.

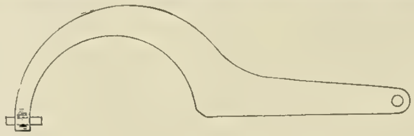


FIG. 6.

the flange should also be machined. As the tube is left one or two inches long to allow for any variation from drawing sizes between the sternpost and the bulkhead, there is often some metal to be taken off at the sternpost end. After the shoulders have been finished to length, this part should be roughed down to clear the nut for the end of the tube; threading the tube to fit this nut being the next operation.

This nut is shown in Fig. 2. It is simply a round iron ring threaded internally, four holes being bored, as shown, for tightening and unscrewing. The spanner for this nut is shown in Fig. 6; the pin which fits into the holes being simply a piece of mild steel of suitable diameter, which need not be fastened into the spanner in any way.

After fitting on the nut, the next step is to bore out the tube for the brass liner shown in Fig. 5. Still keeping the tube on the lathe centers, the steady rest (Fig. 3) should be fitted. This is simply two hardwood blocks—beechwood being very suitable—fitted into a cast iron support. After fitting the blocks to the tube and screwing up the bolts, the lathe center should be slacked back a short distance and the lathe run for a short time to see if the tube sinks down into the rest. Grease or tallow should be used to lubricate the wood blocks. The surplus metal should now be cut off, and the tube finished to length.

The inside is now bored out to gage size, a suitable boring bar carrying a double-ended cutter being used for the smaller sizes, while for the larger ones a suitable head carrying four tools may be used. This completes the turning operations on this end.

The tube is now reversed in the lathe. As the bearing strip at the flanged end is larger in diameter than the part which fits into the sternpost, new bearing blocks must be fitted, the tube being supported on the bridge center. After fitting the rest, and still keeping the bridge center, the outside edge may be turned and the flange faced up to the proper thickness. The bridge piece is now removed and the tube bored out to gage size for the stuffing box and neck ring. This completes the turning operations on the tube.

The neck ring and gland are now machined to size, but as they are simple turning operations, no description is necessary. The neck ring is made of brass; the gland of cast iron and bushed with brass.

In turning the liner which fits into the outer end of the tube, the outside diameter is made a nice driving fit for the tube, the bore is machined to drawing size, and need not be very exact, as lignum vitæ strips are fitted into it for the shaft-bearing, this wood being very suitable for journals under water. To facilitate fitting in the wood, a small brass strip is pinned lengthwise along the bore of the liner, being less in thickness than the finished size of the wood. As it is kept toward the top of the tube, it forms a channel for lubricating the bearing.

The liner is again placed in the lathe and the wood bored out to fit the liners on the tail shaft. It should not be made too nice a fit, because if the tube should be lying outside in the wet some time before fitting the shaft and tube into place in the ship, the wood may swell enough to cause considerable trouble. Before being driven in, the liner is coated with thin red lead. Holes are drilled and tapped into the sterntube, through the flange of the liner, and pins fitted in to keep the liner in place. Drilling, tapping and fitting in the studs for the gland, and also the pop on the tube (not shown) for the lubricating arrangement, complete the machine work. W. Burns.

A Unique Experience.

The steamers *Grand* and *Rapids* had a unique experience about the first of May, when an attempt was made to take them through the locks at Kaukauna, Wis. After the gates

were opened the boats were drawn partly into the lock by suction, but there it was found that the breadth of the beam and width of the lock were approximately the same, each being about 35 feet. The ships stuck to the side of the locks and would not move. After investigating, Captain J. F. Cavanaugh decided to grease the sides of the ships. The grease was applied and the boats passed through.

Trouble with the Main Steam Pipe.

The steam-pipe system on board a boat is perhaps one of the most important features of its equipment, and yet one which is liable to the least amount of inspection and, it would appear, the greatest defects in design. It is an extremely difficult thing, owing to the small amount of space available for the purpose, to adequately arrange the piping so that it shall be properly trapped at every point, and so that adequate precautions are taken to ensure absence of undue strain due to expansion and contraction. Moreover, in spite of regulations as to safety, it sometimes occurs that either by accident or for cheapness material is put in which is not quite up to the standard, and even, if in the first place, the workmanship and material are quite good, the boat is sometimes run past the limit of safety in point of time without adequate overhauling and inspection.

These remarks may apply to some extent to an accident which occurred to the main steam pipe on board a boat known to the writer. This pipe was made of copper and had no expansion joint. There were, however, two bends in it, in order to allow a section of the pipe to run at a lower level, and these two bends were considered sufficient to allow for expansion. On one voyage, however, the steam pipe opened on its longitudinal seam at one bend, and a little further along the length the pipe had cracked opposite to the seam at the other bend. The trouble was first detected by the discovery of a hissing sound from the top of the boilers, and as the pressure was at the time right up to its full working point, or at 160 pounds per square inch, an examination was made from a safe distance. Steam was seen issuing from the defects in such a large volume that it was easily seen that the size of the fracture was considerable. For this reason the fires were at once checked, and the engines opened out to their fullest possible extent. At the same time extra water was pumped into the boilers and the feed heaters were shut off. These operations were all done as nearly as possible at the same time immediately after the discovery of the trouble, all the engineers hastening to minimize the trouble. As soon as the pressure was lowered sufficiently, that is to say, to about 125 pounds, the main stop valves were closed, thus cutting off the escape of steam from the fracture. As the way to the main stop valves lay over the defective pipe the reason for lowering the pressure is obvious.

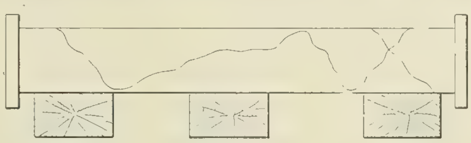
After steam was shut off a careful examination at close quarters was made and two cracks were discovered, one about 3 inches long and the other about 5 inches. In order to repair these a Muntz metal patch was cut out and bent to fit the pipe at each of the fractures. This patch was made of 1 1/16-inch stuff, about 3 inches wide, and long enough to lap over the ends of the cracks. Clamps were then made of strap iron, ¼ inch by 1¼ inches, and bent so as to clamp round the pipe. By means of these the patches were very strongly secured to the faulty pipe. Three clamps were used for the smaller crack and four for the larger one. Each patch was put on the pipe over a joint made of rubber jointing, and the whole collection was then tightened up by means of the clamps. After this iron-seizing wire was wound over the entire length of both the patches, and also for a good distance beyond the ends, in order to strengthen the pipe and prevent the cracks from extending. Steam was then admitted carefully to the repaired pipe, and it was found that a satisfactory repair had been executed, no further trouble being encountered. This may be considered as a fairly quick repair job, as the ship was stopped only for a matter of two hours, and on restarting everything was found quite right.

After a run of about twelve days, on arrival of the boat at port, the pipe was condemned and a new one fitted. After removal from position the condemned pipe was found to have deteriorated considerably, as some pitting was discovered on the interior. Moreover, the metal was very brittle. This defect is a somewhat common cause of trouble in copper pipe which is exposed to high temperatures and alternate compression and expansion, due to changes of temperature, which should make engineers somewhat careful as to its use without periodical inspection. Chas. P. Starkweather.

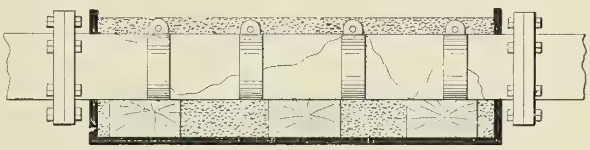
Trouble with Frozen Pipes.

One source of worry which the engineer of a ship trading in cold climates will find is the disastrous effect of frost in bursting pipes containing water. No matter how careful he may be in seeing that all pipes and vessels are systematically drained, he is liable to be caught now and again, and a considerable amount of trouble may be caused. One of the most frequent locations of trouble of this nature is in the tank-filling pipes along the tunnel. These, if not properly attended to and drained, are almost sure to contain water. Moreover, if the ship is by the head or stern, and the aftermost tank valve is shut down, water will be lodged in the pipe.

The best plan in order to make sure of things in frosty weather is to break a joint in the pipe. As a rule, there is a section of pipe in such a system about 4 or 5 feet long, which



PIPE ON BLOCKS



PIPE WITH CLAMPS IN CEMENT

is made of cast iron, and this is usually the member that is found in from ten to twenty pieces when a thaw comes. As it often occurs that the ship is making for a port where a new pipe would cost a good deal of money, and as, moreover, the captain may be in a hurry to run up the tanks, it is useful to bear in mind the following hint for repairing such a pipe, no matter how many pieces it may have been broken into:

These pieces should be brought into the engine room and carefully placed on suitable chocks of wood, fitting in the pieces until the pipe is complete. When this is done clips or bands should be made, in order to hold the pipe together, so that it can be lifted in one piece. This requires in some cases considerable ingenuity, and, of course, it will not be air-tight. When, however, it is in this position it can be taken back along the tunnel and rejointed in the usual way. After this a rough box or trough is made, taking in the full length of the broken pipe and covering all the fractures. This must then be filled in with Portland cement, and it will be found that after this has set the pipe will be perfectly tight and capable of doing the work that is required of it.

J. M. Speedwell.

Repairing the Crank Shaft of a Triple Expansion Engine.

The mishap occurred in a large tramp steamer, on a voyage from Argentine to the Continent. The intermediate-pressure crank twisted round on the after portion of the shaft, finally leaving it and stopping near the bottom center, at about 120 degrees from its proper position.

The valve casings were arranged at the forward ends of each cylinder, and the shaft consisted of three cranks, all exactly alike in every respect; a very fortunate arrangement, as it turned out. The three were fixed at the usual angle, 120 degrees apart, each crank shaft carrying its own eccentric.

Each crank shaft consisted of five pieces: crank pin, two webs and two short pieces of shafting, with coupling ends. The different pieces were shrunk together in the usual way, and were further secured by 1½-inch diameter dowel pins, fitted half in the webs and half in the shaft. In passing, the writer would suggest that these pins should be frequently examined, as he has met with several cases where they have worked slack.

The after web of the intermediate-pressure crank shaft had been imperfectly fitted, and in service the dowel pin had loosened, until it finally dropped out, being subsequently found in the crank pit. At the time of the accident the engines were running freely, and there was no reason to suspect trouble. Then, without any warning, the engine made a few spasmodic jerks, and then stopped, with the cranks in the position mentioned above, the low-pressure crank in its usual position and the intermediate-pressure and high-pressure 120 degrees away. Steam was roaring through the low-pressure relief valves.

It was some little time before the relative position of the cranks was noticed, as on the first preliminary examination everything appeared to be in its proper place. Then the best part of a day was taken up in attempts to move the low-pressure crank round to the others, by the aid of turning gear, screw-jacks, etc., but without success. If this could have been done it was intended to drill several holes and fit dowel pins in them to hold the cranks together.

Finally it was decided to remove the defective intermediate-pressure shaft, and replace it with the high-pressure shaft, which, it will be remembered, was the same size in every respect. This was done, fresh keyways being cut and the eccentrics fitted on the new shaft to meet the new conditions of the valve gear. The high-pressure valve was taken out, and steam allowed to flow through the exhaust port to the intermediate-pressure casing. The high-pressure valve spindle was lashed and left in the gland, and the gland tightened to prevent leakage. As the high-pressure connecting rod, valve gear, eccentrics, etc., were removed when the engine was stripped to change shafts, the high-pressure piston was lowered to the bottom of the cylinder, and the piston gland tightened up.

The trouble occurred at 7 A. M. one morning, and the repairs were completed by 5 P. M. the next day, or after thirty-four hours' continuous work. The arrangement answered very well, and the job was a very creditable one. The engineers were assisted the whole time by the deck hands, who tackled and handled the gear as it was disconnected.

There was a spare length of crank between decks, but it could not be got at, as there was a grain cargo. If it could have been used there would have been a good deal of trouble, and it would have taken up a lot of time rigging gear to strike it down into the engine room.

On restarting, the boiler pressure was reduced from the original 180 pounds to 100 pounds, but it was found more economical and to give easier steaming to regulate the throttle valve, so as to obtain about 65 pounds in the intermediate-pressure valve casing and 15 pounds in the low-pressure. The revolutions were reduced by 6 and the coal by 2 tons.

On arrival at the Continental port it was decided to leave the engine as it was till the vessel's arrival in England, where the faulty shaft was replaced.

Repairs to Sea Cocks, Etc.

Engineers on board ship have frequently to execute repairs by means of expedients which would not be thought of on shore, and they are handicapped by the fact that they do not always have a proper equipment of spare parts and workshop tools. One of the most common troubles is the leakage to be found in steam or water cocks, the plugs of which are very apt to corrode. This makes it impossible to keep them continually tight, and if frequent grinding is resorted to a considerable amount of metal would be worn away from the box, depreciating its life considerably.

A very good plan of executing a repair of this nature, if the ship is running in a trade where shore repairs are expensive, is as follows (it applies to sea cocks of all descriptions, no matter what the size of the plug may be): After withdrawing the plug from the cock, it should first be cleaned free of all grease and foreign matter, and then tinned all over with solder in the usual way. The next step is to cut out a paper

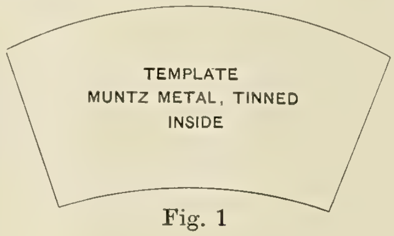


Fig. 1

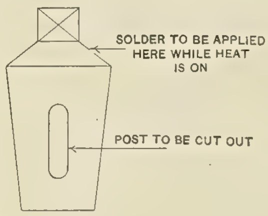


Fig. 2

template to go round the plug, and making a butt-joint on a portion of the cock away from the ports; the shape of this template would be as shown in Fig. 1. A sheet of Muntz metal, 1/32 inch thick, is then cut to suit the template, and then bent round the plug and fixed to it by means of copper wire so as to fit accurately, and also to close together on the butting surface. When this is done the whole plug is brought to a heat sufficient to melt the solder, and at the same time sufficient solder is run round the neck of the plug to sweat the sleeve. When the plug is cooled again, it only remains to cut out the ports from the sleeve and file off any humps that may be found, and then to grind the cock in its place in the box. In this way the abrasion of metal which occurs from repeated grinding, and which would eventually make the cock too small for the box, is virtually added on to the cock, giving the gear a fresh start. In order to bring the plug to a good heat sufficient to melt the solder, either a paraffin blow lamp may be used or else a large nut heated to a blood-red temperature may be placed over the plug. Alternatively, the fire-bar tongs heated up will serve the same purpose. George Halsey.

Fractures in Propeller Shafts.

A very serious accident which might easily cripple a boat while at sea is the fracture of the shaft which passes through the tunnel to the propeller. It very much depends upon the nature of the fracture as to the course which should appropriately be adopted, and the repair would be very much complicated if the shaft were bent. If, however, it is a clean fracture without bending it can be repaired as follows:

The ends of the fracture should be brought firmly together, and then a hole about 1½ inches in diameter should be drilled clean through the center of the break. A pin should then be made to fit into the hole, and this really forms a key between one part of the fractured shaft and the other when it is set turning again. The ends of this pin should be kept flush with the surface of the shaft over the break. Some bars of iron, 2½ or 3 inches thick, should then be obtained and cut to length of about 12 or 14 inches. It is advisable to cut keyways parallel with the axis of the shaft, passing from one-half of the break to the other in order to hold these bars, as

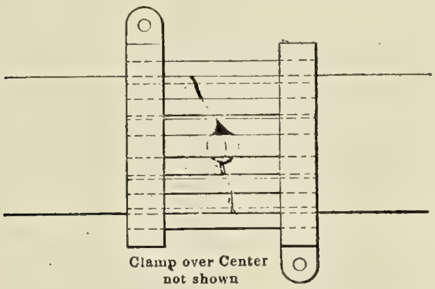


FIG. 1

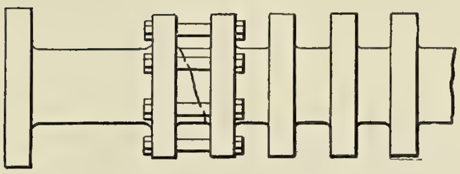


FIG. 2

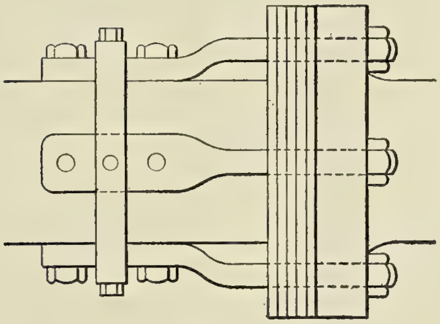


FIG. 3

VARIOUS METHODS OF TEMPORARILY REPAIRING A FRACTURED PROPELLER SHAFT.

shown in Fig. 1. The keyways should be about ½ inch deep, and one of the bars should lie over each end of the pin, so as to keep it in position. Over each end of the series of bars thus placed round the shaft strong iron clamps should be bolted, as shown, or, if this is not possible, the bars should be pinned onto the shaft by drilling tapping holes into the shaft, and putting screwed pins through the bars and into the solid metal of the shaft. It is preferable, however, to have the clamps, which can be made by means of the portable forge.

With the aid of this repair it will be found that the boat can be allowed to proceed, although care should be taken in starting the engines to avoid sudden strain on the shaft. It should be carefully watched should the boat be running in a following sea, as any lifting of the propeller out of the water and sudden dipping in again will impose severe twisting strains on the shaft, which will soon loosen the repair.

Should a fracture occur in the section of the shaft between the thrust collars the trouble is rather difficult to get at, but may be repaired by drilling tapping holes through two of the collars adjacent to the fracture. The number and sizes of holes should be sufficient to afford enough metal to stand the twisting strains imposed on the shaft. The bolts should be driven into place and screwed up tight, so as to join the edges of the fracture firmly together. The engine will now be able to drive the shaft with the remaining collars, but inasmuch as there is now less bearing surface interposed to take the endwise thrust of the propeller it is obvious that the speed of the engine will have to be reduced in proportion to the number of thrust collars which have been thrown out of action by the repair. This breakdown is illustrated in Fig. 2.

Sometimes the fracture occurs at one of the flanges which couple the various sections of the tunnel shaft together, and one of the forms of fracture is the complete shear-off of the flange from the shaft. This at first sight appears to be an accident which requires more than an ordinary seagoing equipment to overcome, but Fig. 3 gives an idea of how, in practice, the repair may be made sufficiently strong to enable the ship to be brought home to port. The end of the broken shaft should be squared up so that it will abut accurately against the unbroken flange end to which it is adjacent. Then the squared-end plates should be fitted to make up the thickness of the broken flange, so as to give the distance along the length of the tunnel. The coupling bolts belonging to the flange coupling are now taken, and lengths welded onto them of sufficient extension to allow tap bolts to be fitted so as to bolt onto the fractured part of the shaft. This extension should then be clamped onto the shaft and tap bolts placed over the clamps. It will be seen, therefore, that projecting out from the broken part of the shaft and through the distance plates will be the requisite number of screwed rods which will go to form the coupling bolts. The two sections of shaft can then be coupled up in the usual way, and if care is taken to start up the engine easily it will be found that the repair will carry the boat through.—J. A. Seager, in *Power and the Engineer.*

Newcastle-on-Tyne, England.

Decrease in American Shipbuilding.

Reports from the Bureau of Navigation show that during the year ended June 30, 1909, 1,362 merchant vessels of 232,816 gross tons were built in the United States and officially numbered by the Bureau of Navigation, compared with 1,506 of 588,627 gross tons during the fiscal year 1908, which was the record year of American shipbuilding. This year's output was the smallest since 1898; but shipbuilding contracts indicate a material increase during the new fiscal year.

On the Great Lakes thirty-six steamers of 88,436 gross tons were built, including the *Shenango*, 8,047 tons, the largest vessel ever built on the Lakes. Only two ocean steamships, *Mars*, 5,451 tons, and *Mohawk*, 4,683 tons, were built. The *Edward B. Winslow*, Bath, Me., 3,424 tons, is the largest wooden schooner ever built. No vessels for foreign trade and no square-rigged vessels were built during the year. Of the year's output, 60,952 tons were barges and canal boats.

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Steam Engine Indicators for Marine Work.

With this issue we begin publication of a series of short, illustrated articles describing various types of steam-engine indicators suitable for marine work which are manufactured in Great Britain and America. These articles are published as the result of many inquiries from our readers who have become interested in Lieutenant Root's valuable series of articles on the indicator, which was begun in the July issue. It is not our intention in the brief descriptions of commercial indicators to present the manufacturers' claims for these instruments, but simply to publish the facts regarding the design and construction, pointing out the reasons for various modifications and their probable effect on the accuracy of the instrument. A careful perusal of these, and a clear understanding of Lieutenant Root's comprehensive article, should give the average marine engineer a thorough knowledge and understanding of the requirements of a good indicator for marine work, so that he can judge for himself what type is necessary to suit his own particular needs.

Notes on Producer-Gas Operation.

Small marine producer-gas plants are more extensively used in Holland at the present time than in any other country. They are used chiefly on barges and canal boats, where it is impossible to employ experienced engineers to care for the plants; and since these are somewhat the same conditions under which it is expected that the immediate development of producer-gas for marine work will take place in other countries, it is interesting to note the successes and failures which the bargemen of Holland have had with these plants. Elsewhere in this issue we publish a thoroughly practical article describing the construction and operation of these plants. The author points out that, contrary to the general impression, a marine suction gas plant is a very sensitive power plant to operate, as compared with one employing steam or oil engines. The ordinary troubles which are encountered in the operation of any gas engine are likely to be augmented when producer-gas is used as the fuel by additional troubles with the producer itself. It is, therefore, absolutely necessary that the man in charge should have a good, practical knowledge of the working of the plant in order to operate it successfully, although he need not be an experienced engineer or mechanic.

Without going into the details of the particular plant illustrated and described, the following points should be noted with regard to the operation of a producer-gas plant: The producer itself is likely to fail because of insufficient gas when starting, a bad quality of gas, or no gas while working. The first will happen if the motor is started before the producer is completely charged and combustion well under way. The second the author attributes to a lack of hydrogen in the gas. However true this may be as regards the type of plant used in Holland, it should be remembered that there are many opinions regarding the value of hydrogen in producer-gas. Many engineers consider not only that hydrogen is not an essential constituent of producer-gas, but that its presence in the explosive mixture involves a distinct loss, due to the formation of water vapor when combustion takes place. The third difficulty is usually caused by clogging of the gas passages in some part of the apparatus, and should be avoided by careful operation.

As far as troubles with the motor are concened, the reader will do well to note carefully the points brought out by Mr. Smith in his paper on "Gas Engine Construction for Producer-Gas Use," an abstract of which is published on page 387. Doubtless there are some

things in this paper which will be severely criticised; but, on the whole, Mr. Smith brings out very strongly the main requisites for successful operation on producer-gas, and it is likely that troubles will be due to the fact that these points have either been ignored or not fully understood. Whatever opinions are held regarding the value of high compression and the effect of a large percentage of hydrogen in the explosive mixture, it is certain that an ample and effective ignition gear should be provided; that the piping and valve passages should be of sufficient size and without abrupt bends, and that the compression space in the engine should be as small and free from openings or pockets as possible.

Combined Reciprocating and Turbine Machinery.

The combination of reciprocating and turbine machinery was suggested by Mr. Parsons primarily to increase the power obtainable by the expansion of steam beyond the limits possible with reciprocating engines. There was no doubt that this object could be attained, and that increased power for a given steam consumption would result; but it remained to be proved that such a system of combined machinery could be efficiently employed for the propulsion of a ship, since it involved the use of at least three propellers and the determination of such questions as what percentage of the total power should be applied to the turbine-driven propeller for the most efficient results, etc. Of course, such a system of combined machinery was designed for use only on vessels of moderate speeds, for which turbines alone would not be efficient.

The first merchant vessel to be fitted with this system of propelling machinery was the *Otaki*, of 9,900 tons deadweight carrying capacity and 12 knots designed speed, built by Messrs. Denny, of Dumbarton, for the New Zealand Shipping Company. The *Otaki* is virtually a sister-ship of the twin-screw vessels *Orari* and *Opawa*, previously built by the Messrs. Denny for the same company, and fitted with reciprocating engines. These vessels have given a splendid chance for comparison of the two systems of propulsion, and the results obtained, both on trial and in regular service, have recently been made public by Engineer-Commander Wisnom in a paper read at a joint meeting of the Institution of Engineers and Shipbuilders in Scotland and the North East Coast Institution of Engineers and Shipbuilders.

On her trials the *Orari* obtained a mean speed of 14.6 knots on the measured mile at Skelmorlie, while the *Otaki*, under the same conditions, with apparently greater ease obtained a mean speed of over 15 knots on a total water consumption per hour of 6 percent less than the *Orari*, while the total water consumption per hour in the *Otaki* at 14.6 knots was 17 percent less than in the *Orari* at the same speed. The proportion of total power developed in the turbine of the *Otaki* was found to vary with the speed. At full power this proportion was about one-third, while at very low speeds the turbine was doing only a small proportion of the work. At a speed of 14.6 knots the indicated horsepower in the *Orari* was 5,350, and the corresponding power in the *Otaki* was 5,880. At this speed the effective horsepower was 3,210 in the *Orari* and 3,350 in the *Otaki*, the propulsive coefficients being thus 60 percent and 57 percent, respectively. The propulsive coefficient in the *Otaki* at full speed fell to 54 percent.

On account of the distinction between the shaft horsepower and indicated horsepower in two vessels driven respectively by reciprocating engines and steam turbines, it is important not to rely wholly on the foregoing figures, which simply give a percentage based on the total water consumption and speed. Comparing the water consumption per effective horsepower per hour, the *Otaki* showed a gain of 20 percent, and again comparing the water consumption of the two vessels per indicated horsepower, taking the indicated horsepower for the *Otaki* as that obtained in the *Orari* for corresponding speeds, the gain in the *Otaki* was 17 percent.

In addition to the trial results, Mr. Wisnom gave some figures covering the performance of the vessels in actual service. On the voyage from Liverpool to Teneriffe the coal consumption of the *Otaki* was 11 percent less than the means for the sister-vessels, *Orari* and *Opawa*, under similar conditions, and at practically the same speed. A careful comparison of the coal consumption of the *Otaki* for the round voyage with that of the sister-ships on similar voyages at the same speed shows an apparent gain of about 8 percent. This figure, however, it is expected will be bettered.

The dimensions of the engine room in the *Otaki* were the same as in her sister-ships, and were found sufficient to admit of an arrangement of the machinery which gives satisfactory access to all working parts. The total weight of machinery in the *Otaki* was about 30 tons more than in her sister-ships, or an increase of about 3.25 percent. In view of the greater economy of the combination system, the boiler power of the *Otaki* might have been reduced. If this had been done, the total weight of the combination system would not have exceeded that for reciprocating engines, while the saving in bunker capacity would more than have balanced the loss in cargo-carrying capacity due to the three shaft tunnels. These losses in the *Otaki* were compensated by increasing the length slightly.

On the whole, the performance of the *Otaki* seems to bear out the expectations that a high degree of economy may be expected with this form of machinery; that is, that in vessels of low speeds additional power can be obtained for the same water consumption; but the problem still remains in each case of how to utilize this power most efficiently; that is, how to make the three propellers as efficient as twin screws, and what proportion of the power to develop in the turbine.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Aug. 1.	Sept. 1.
BATTLESHIPS.					
S. Carolina	16,000	18½	Wm. Cramp & Sons	96.5	98.0
Michigan	16,000	18½	New York Shipbuilding Co.	99.4	100.0
Delaware	20,000	21	Newp't News Shipbuilding Co.	91.8	94.8
North Dakota	20,000	21	Fore River Shipbuilding Co.	90.3	93.5
Florida	20,000	20¾	Navy Yord, New York	24.8	29.2
Utah	20,000	20¾	New York Shipbuilding Co.	33.2	38.1
TORPEDO-BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons	95.6	96.4
Lamson	700	28	Wm. Cramp & Sons	88.4	90.3
Preston	700	28	New York Shipbuilding Co.	90.1	93.0
Flusser	700	28	Bath Iron Works	90.0	92.4
Reid	700	28	Bath Iron Works	84.2	89.6
Paulding	742	29½	Bath Iron Works	21.7	27.3
Drayton	742	29½	Bath Iron Works	20.7	24.6
Roe	742	29½	Newp't News Shipbuilding Co.	57.4	60.9
Terry	742	29½	Newp't News Shipbuilding Co.	51.9	58.5
Perkins	742	29½	Fore River Shipbuilding Co.	44.6	51.7
Sterrett	742	29½	Fore River Shipbuilding Co.	41.2	48.6
McCall	742	29½	New York Shipbuilding Co.	22.5	25.3
Burrows	742	29½	New York Shipbuilding Co.	22.4	25.4
Warrington	742	29½	Wm. Cramp & Sons	32.7	39.1
Mayrant	742	29½	Wm. Cramp & Sons	37.2	45.2
No. 32	...	....	Newp't News Shipbuilding Co.	0.0	0.6
No. 33	...	....	Bath Iron Works	1.1	2.2
No. 35	...	....	Fore River Shipbuilding Co.	0.8	2.5
SUBMARINE TORPEDO BOATS.					
Stingray	...	..	Fore River Shipbuilding Co.	95.0	97.5
Tarpon	...	..	Fore River Shipbuilding Co.	95.0	98.8
Bonita	...	..	Fore River Shipbuilding Co.	90.6	92.0
Snapper	...	..	Fore River Shipbuilding Co.	87.6	92.0
Narwhal	...	..	Fore River Shipbuilding Co.	94.5	98.2
Grayling	...	..	Fore River Shipbuilding Co.	90.6	91.8
Salmon	...	..	Fore River Shipbuilding Co.	81.8	83.7
Seal	...	..	Newp't News Shipbuilding Co.	23.2	24.8
Pickerel			The Moran Co.	4.3	8.4
Skate			The Moran Co.	4.3	8.5

ENGINEERING SPECIALTIES.

Clifton Marine Gasoline (Petrol) Engines.

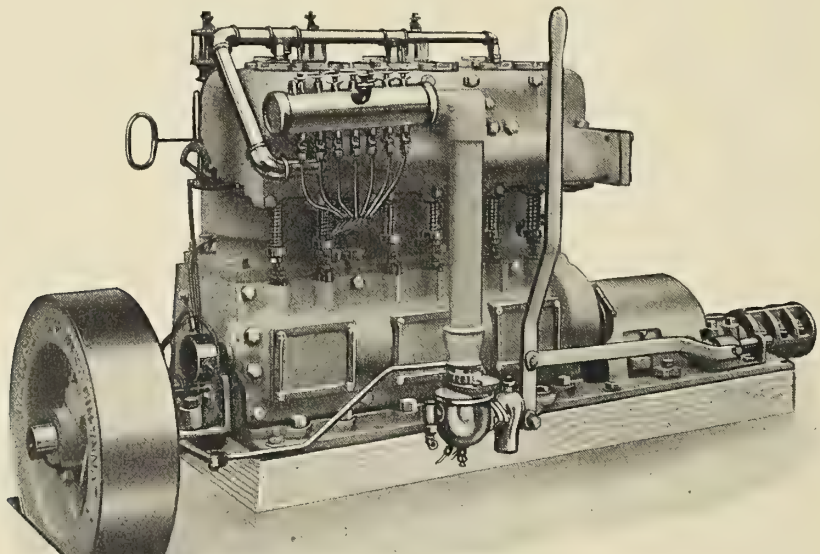
The Clifton marine engine, manufactured by the Clifton Motor Works, Cincinnati, Ohio, has been on the market for a number of years, being used largely in the Southern and Western States along the Gulf of Mexico and its tributary bays and streams. These engines are suitable for heavy sea-going vessels, river boats, lake vessels and cruising launches. The Clifton engine is one of the simplest four-cycle engines on the market, the main idea in the design being to bring the motor down to the fewest number of parts and to make these parts extra strong and substantial. As a result, this company claims never to have had a broken crank shaft or connecting rod, and that the reversing gear, which is also very substantially built, has stood the test of practical service without failure.

The cylinders are cast with hoods integral with the cylinders, so as to do away with packing. The design is such that there is no packing under pressure anywhere in the engine. The exhaust is water-jacketed along the entire length of the engine, and at the end of the exhaust valve a small stream of water is admitted, which cools down the exhaust gases so that there is no danger of the exhaust pipe setting fire to the boat. Simplicity is also obtained in the design of the water pump and circulating system, and all passages are large and unobstructed. The engine is equipped with an automatic throttling governor, to prevent it from racing when the clutch is disconnected. This is a point which will be greatly appreciated in boats which are operated by one or two men, where the pilot frequently operates the clutch on the engine.

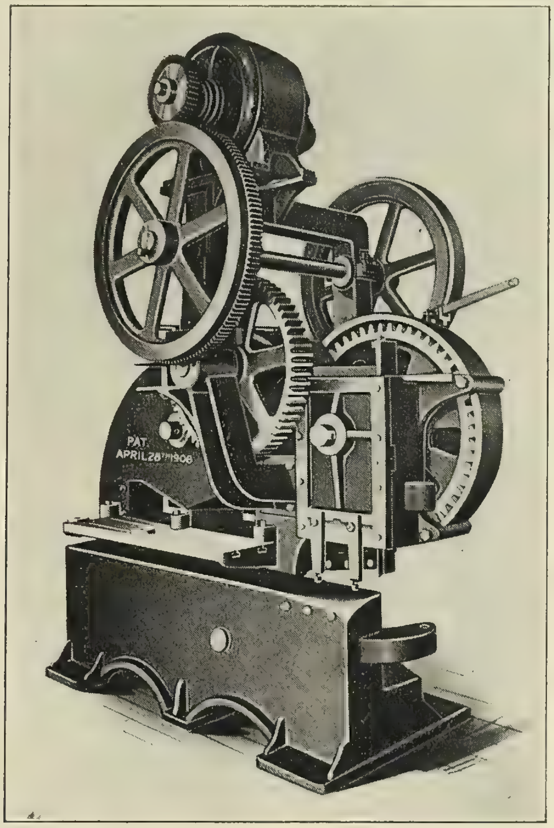
A Universal Plate, Bar and Angle Shear.

To cut angles or plates on an ordinary punching and shearing machine requires considerable changing, which consumes time. A machine which is always ready for any kind of work, and is therefore a great labor-saving tool, is placed on the market by the Covington Machine Company, Covington, Va. In this machine a plate shear is placed on the front of the machine with angle shears in two square openings in the side. The latter will cut right and left angles of even or uneven legs to any angle up to 45 degrees. The shears are all driven from one pulley or motor. The angle shears, with their knives, travel at angles of 45 degrees with the horizontal, and the plate and angle shears can be operated singly or together. A patent clutch mechanism, which contains no springs to keep up a continual knocking of the jaws, is arranged to positively stop at the highest point of the stroke. The clutch lever is universal, and can be swung to any position to suit the operator.

It has always been a difficult matter to cut angles with uneven legs, unless large, special machines, too expensive for ordinary manufacturers, have been installed for this purpose. It is claimed that this shear embodies all the best features of a double-angle shear, and also the best features of a plate and bar shear. Bars may be cut by either the angle or plate shear.



The machines are designed to occupy the minimum of room, are strongly geared, and of massive design throughout. The gear covers, besides acting as safety guards, form the bearings



for the gears, and the gears in turn form the bearings for the eccentric shafts, so that by this method a maximum stiffness of design and protection for the workmen are secured.

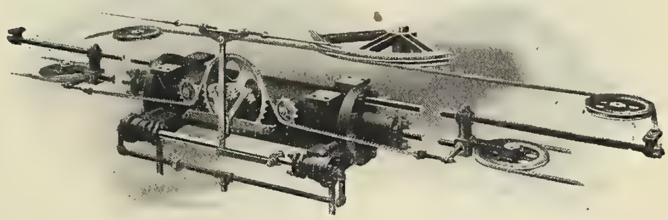
An Improved Steering Engine.

The failure in the past of steering engines in which the movement of the tiller ropes was taken directly from a reciprocating piston instead of from a revolving drum, has been due entirely to their valve mechanism. Either the rudder movement was too sudden, or the rudder could not be compelled to retain the desired position perfectly and indefinitely. The Nash-Century steering engine, which we illustrate, is made with a novel valve motion, by means of which, it is claimed, these objections are completely overcome. The engine is free from a multiplicity of wearing and power-absorbing parts. The piston rod is prolonged equally from both ends of the steam cylinder and terminates in sheaves, through which the tiller ropes pass in a way to give them a travel at the quadrant equal to twice that of the piston. Steam pressure admitted near each end of the cylinder acts upon both ends of the piston to hold it in position, and at all times balances it against the pressure on the rudder.

The valves which admit pressure to the cylinder are of the piston type and have a common spindle. When the controlling gear is stationary, these valves are in mid position; that is, the valve rings cover the steam ports with slight overlap and prevent admission of steam to the cylinder.

The operation of the steering wheel to port or starboard as desired causes the control lever to move. This control lever, swinging about the floating fulcrum, transmits its pull to a connecting rod, the other end of which communicates with the valve spindle. The resulting movement of the valve spindle uncovers the ports, admitting steam through the valve at one end of the cylinder and exhausting through the valve at the other end. The unbalanced cylinder pressure then moves the piston rod, and thus, by means of the sheaves attached to the ends of the piston, the cables to the rudder quadrant are moved, imparting corresponding movement to the rudder.

At the same time the movement of the piston causes the block chain attached to the sheave blocks at each end of the piston to rotate the sprocket and its concentric pinion. The sprocket and pinion are keyed to the same shaft and are practically one piece. The pinion meshes with an arc which swings about a center on a bracket on the cylinder casting. Extending from the center pivot of the arc and diametrically opposite to the toothed part is a projection which forms the fulcrum for the control lever. This explains why we pre-



viously spoke of this fulcrum as "floating." The movement of the arc makes the fulcrum travel in a radial direction and opposite to that taken by the valve spindle in opening for steam.

Thus the instant the piston has reached the desired position it has, by its own action as transmitted through piston rods, chain, sprocket, pinion, arc, fulcrum and connecting rod, automatically closed the valve and shut off the steam. To keep the piston moving it is consequently necessary to keep the control lever moving by operating the steering wheel. In other words, the steering wheel operates against an automatic cut-off, which constantly acts to prevent movement other than that desired as indicated by the steering-wheel dial.

In the event of undue strain being put upon the vessel's rudder, it is claimed that the engine instantly operates as a buffer. The action is just the reverse of that necessary for steering, but accomplishes the same purpose, that of keeping the rudder exactly where desired. The movement of the rudder forces the piston to travel. The travel of the piston opens the piston valve at the end of the cylinder towards which the piston is traveling. Steam is thus admitted in proportion to the movement of the valve, and by the time the piston has been driven back to its proper position the steam is again automatically shut off.

This gear is so sensitive that the turn of one spoke of the pilot wheel will perceptibly alter the course of the boat. The action is perfectly noiseless, as the piston and other working parts move slowly. The steam cushioning of the rudder is also claimed to be a great advantage, as it makes the rudder safer from damage in heavy seas, or from sudden impact with solid objects, and does away with the necessity of spring-cushioning the quadrant.

The Nash-Century engine is intended as a "steam only" machine, but, where desired, provision may be made for hand steering also. It is manufactured by the Century Engineering Company, Ogdensburg, N. Y.

Kelso Models.

The oldest firm of model makers is the Kelso Company, Glasgow. Originally the firm made optical and philosophical instruments, but it soon undertook the building of ships' models and the manufacture of various small articles that go into ships' models, such as engines, fittings, etc. The models are usually made on a scale of a ¼ inch to the foot, although

sometimes to a scale of ⅛ or 1/16 inch to a foot, from drawings supplied by the shipbuilders. Among the models which have been made by this firm are those of the famous old Clyde tea clippers, the *Shamrock* yachts, and at the present time the models of the new giant White Star liners *Olympic* and *Titanic*. From the illustration it will be seen that the models are complete in every detail, including rigging, deck fittings, etc. Recently this company has done much model work in connection with experimental towing tanks.

INDICATORS.

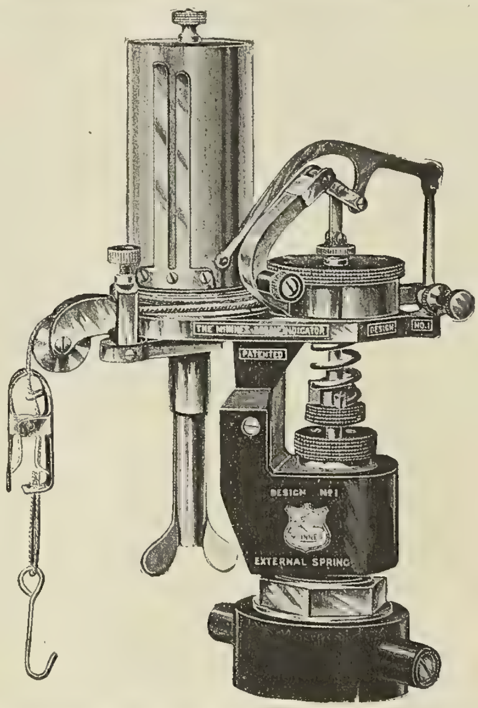
The McInnes-Dobbie Indicator.

In these indicators the pressure spring is placed above and outside the steam cylinder, a position in which it is kept comparatively cool when the indicator is under steam. For this reason the accuracy of the instrument cannot be impaired by the temperature of the steam. Not only this, but the spring can be very accurately calibrated under normal conditions and not at a high temperature, as is necessary when the spring is in contact with the steam.

The vulcanite cover caps above the piston chamber and the pressure spring unscrew, allowing the piston rod and parallel motion to be removed bodily from the instrument, for the purpose of changing the spring or cleaning the cylinder. These caps screw to the indicator frame and the lower cap acts as a guide to the piston rod, insuring perfect alinement and preventing escaping steam from passing upwards to the diagram.

The parallel motion is so constructed that the long lever carrying the marking point is not overhung, but is mounted so as to intersect the vertical axis of the pressure cylinder. It, therefore, receives a uniform and direct motion from the piston with a minimum liability of error, due to friction. In instruments having overhung arms a side strain, tending to bend the joint pins, is inevitable, and the friction thus set up results in a considerable drag on the linkage and in serious wear on the sockets and pins. The bearings of the several joints are broad and solid, specially hardened, and the motion is adapted to withstand severe strain without slackening at the joints, with corresponding play at the pencil point, which soon becomes a source of serious error.

The piston is of a patent type, made of steel, case-hardened, and it is claimed that it is unaffected by steam temperatures and does not expand and stick at high pressures. It is turned from a solid piece, and the central space affords accommodation for any grit present in the cylinder, removing it from the cylinder walls and preventing tearing and friction. The piston and all moving parts are of very light weight, in order to reduce to a minimum the inaccuracies due to inertia. The piston



travel is multiplied six times at the pencil point, consequently the piston itself has a very short travel. The drum spring is spiral, of light weight, and is fitted with brass ends. With this style of spring the tension of the drum can be conveniently altered to suit the speed of the engine, and in event of breakage can be readily replaced.

The indicators are manufactured by Dobbie McInnes, Ltd., Glasgow.

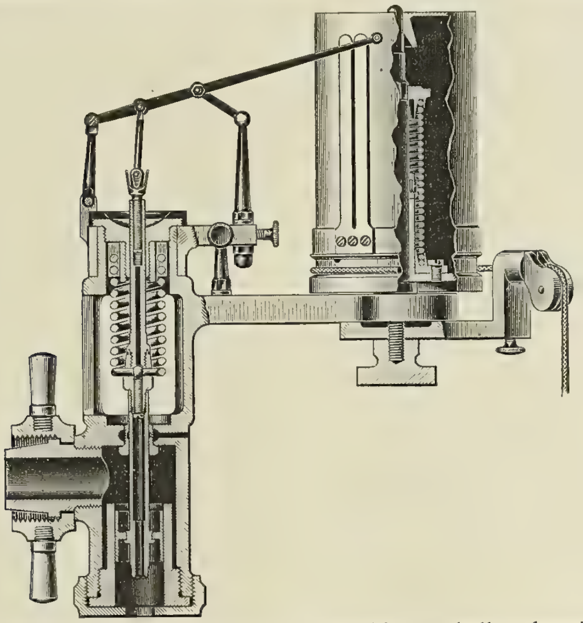
The Star Improved Indicator.

The Star improved indicator, manufactured by the Star Brass Manufacturing Company, Boston, Mass., consists of two main parts—the steam cylinder and the paper drum. The cylinder consists of an outer shell, which forms a part of the main body of the indicator, and an inner shell, in which the piston operates. The inner shell is removable and can easily be replaced when worn. The inner shell extends in one continuous piece of metal to the cap in order to obtain perfect alinement for the movement of the piston. At the lower end the inner shell is comparatively thin and it is surrounded by an annular space. This enables the working part of the cylinder to be free from any distortions that may result from difference in expansion in the inner and outer shells or from undue strain which may be brought to bear upon the body of the indicator. The upper part of the inner shell is surrounded by a channel and communicates with it by a number of holes drilled through the metal. From this channel openings through the body of the outer cylinder carry away the steam and vapor which, in the process of operation, blows by the piston.

The piston consists of a thin cylindrical shell with a transverse web across the center. It is made of tool steel hardened and ground, but the hub at the center of the web is of soft steel, to which the piston rod is screwed. By means of proper

adjustments a flexible connection is provided between the piston and the spring. The upper end of the piston rod is hollow and threaded to receive a swivel head, by means of which any desired vertical adjustment of the position of the pencil can be secured without removing the cap from the cylinder.

The spring, which is one of the most important parts of the whole instrument, consists essentially of only two parts—the head upon which the spring is mounted, and the coil of wire which forms the spring itself. There is no metal at the lower end except a small sphere or ball through which the wire passes and to which it is attached. The ball forms the point



of attachment for the piston, furnishing a ball-and-socket joint. When it is considered that the momentum of the mass of metal in the spring has a decided effect upon the form of the diagram which the instrument produces, the advantage of this form of spring is evident, since the weight at the piston end has been reduced to a minimum.

The pencil movement consists of three parts, and since the degree of perfection with which the rectilinear motion is obtained in this movement is dependent solely upon the accuracy with which delicately-turned pins can be fitted to reamed holes, it is evident that the pencil movement can be made very accurate. The mechanism is so proportioned that the movement of the piston is multiplied at the pencil end six times. The design provides that the pencil does not deviate from a straight line in any sensible degree unless the extreme movement extends more than 1¼ inches from the central position.

Fulton Exhibit, Engineering Societies Building.

The Hudson-Fulton celebration at New York is essentially a recognition of the explorer and the engineer. To show the relation of the latter to the celebration, models of the *Clermont* and other early steamboats, through the courtesy of the Smithsonian Institution, are now on exhibition at the rooms of the American Society of Mechanical Engineers in the Engineering Societies' Building, 29 West Thirty-ninth street. The exhibit includes the *Clermont*, the *Phoenix*, built by John Stevens, and one of John Fitch's early types. Original drawings by Fulton, an oil portrait of Fulton, painted by himself, Fulton's dining table, oil portraits and bronze bust of John Ericsson, models of the *Monitor*, all owned by the society, and Ericsson's personal exhibit at the Centennial Exposition, are also exhibited. Through the courtesy of the Hamburg-American line a beautiful model of the *Deutchland* shows the highest type of the development of steam navigation.

The exhibit will be open to the public every week day from 9 A. M. to 5 P. M.

TECHNICAL PUBLICATIONS.

Reed's Polyglot Guide to the Marine Engine. Size, 11 by 8½ inches. Pages, 174. Numerous illustrations. Sunderland, 1909: Thomas Reed & Company, Ltd. Price, 6s. net.

This polyglot guide to the marine engine is intended to fill a long-felt want among marine engine builders, shipbuilders and seagoing engineers who are compelled to do business in several different countries involving dissimilar languages. The book is divided into eighteen sections, enumerating the various details of boilers, engines, engine-room stores and types of vessels. The parts are all numbered and many of them illustrated. The name of each part is given in English, French, German, Norwegian, Italian and Spanish. There are also alphabetical indexes for each of the languages and a table of monies, weights and measures.

Fighting Ships, 1909. Edited by Fred T. Jane. Size, 12 by 7½ inches. Pages, 492. Numerous illustrations. London, E. C., 1909: Sampson Low, Marston & Company, Ltd. Price. 21s. net.

Since extended reviews of the last two editions of this book have been published in this magazine, undoubtedly the majority of our readers are familiar with the general scope and arrangement of the work. No very striking change has been made in the general features of the present volume, which is the twelfth edition. As before, complete details of all the important warships in the world are given, together with illustrations showing the exterior of the ship and an outboard profile and deck plan, indicating the arrangement and distribution of guns and armor. Part II. contains a number of valuable and timely articles on various matters connected with warship design and construction, including the protection of battleships against submarine attack and the progress of warship engineering.

Probably the one thing which has occasioned more discussion and interest in warship construction during the last year than any other has been the comparative secrecy and mystery which have veiled the plans and development of the latest German battleships and battle cruisers. Considering the difficulty of obtaining information regarding these ships, remarkably complete details have been collected by the author, and, as he does not hesitate to state the source and probable accuracy of his information, the reader is able to form his own conclusions as to the probable value of the various reports and conjectures which are current.

In general, in the present edition, increased space is given to the plans and description of the smaller and less important vessels in various navies. Deck plans of destroyers and torpedo boats are given in nearly every case.

Steam Turbines. (The Power Hand-Book Series). By Hubert E. Collins. Size, 4½ by 6¾ inches. Pages, 186. Figures, 76. New York, 1909: Hill Publishing Company. Price, $1.00 net.

So many books have recently been published on steam turbines which take up the subject from a theoretical standpoint that many practical operating engineers will welcome this little book, which is simply a practical description of a few of the leading types of steam turbines together with some practical notes which have been gathered from the experience of successful engineers in operating steam turbines. The volume includes chapters describing the Curtis, the Allis-Chalmers and the Westinghouse-Parsons turbines, the method of setting the valves of the Curtis turbine, the proper method of testing a steam turbine, auxiliaries for steam turbines and trouble with steam turbine auxiliaries.

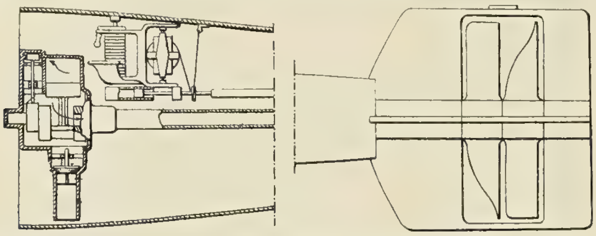
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

917,449. SELF-PROPELLED TORPEDO. ALBERT EDWARD JONES, OF FIUME, AUSTRIA-HUNGARY, ASSIGNOR TO WHITEHEAD & COMPANY, OF FIUME, AUSTRIA-HUNGARY, A CORPORATION.

Claim 1.—In a self-propelled torpedo, the combination of a gyroscope placed above the longitudinal axis of the torpedo, a buoyancy chamber into which the servo-motor of the gyroscope discharges, a sinking valve



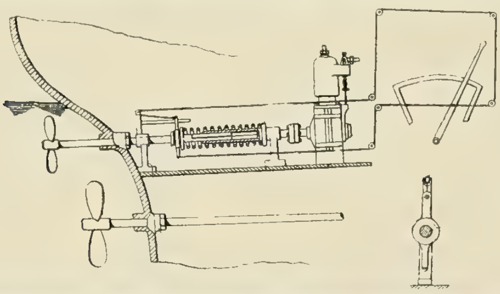
placed in the buoyancy chamber, said valve having a box connected with the exhaust chamber of the engine and a socket opening in close proximity to the bottom of the buoyancy chamber. Four claims.

920,286. FLOATING DRYDOCK. WILLIAM THOMAS DONNELLY, BROOKLYN, N. Y.

Claim 1.—In a floating drydock having separate water compartments, a centrifugal pump in each of said water compartments for the admission and exhaust of water to and from said compartments, power connections for each pump extending from the upper portion of the dock, each of said pumps establishing communication only with the compartment in which it is located and the exterior of the dock and having a combined inlet and outlet to the exterior of the dock, a combined inlet to and outlet from the compartment in which it is located and a single valve for each of said pumps for controlling the passage of water therethrough. Two claims.

921,714. MARINE-ENGINE GOVERNOR. LEWIN D. KISSACK, OF CLOVERDALE, CAL.

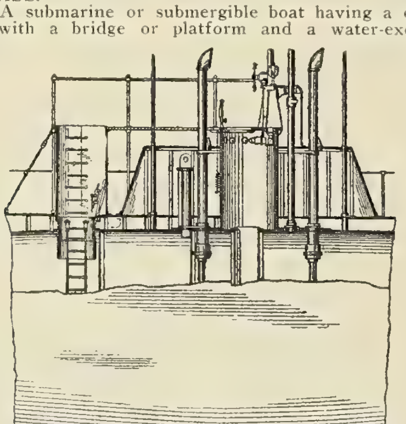
Claim. 1.—The combination with a marine vessel, its propeller shaft, and engine throttle operating means, of a governor shaft, means independent of the main engine for actuating said governor shaft, and a



connection between said shaft and the throttle-operating means arranged to move the operating means toward the closed position upon the emerging of the rear end of the propeller shaft from the water. Two claims.

922,056. SUBMARINE BOAT. LAWRENCE Y. SPEAR, OF QUINCY, MASS.

Claim. 1.—A submarine or submergible boat having a deck hatch in combination with a bridge or platform and a water-excluding hatch



trunk surrounding the hatch and cover and extending up to the platform. Three claims.

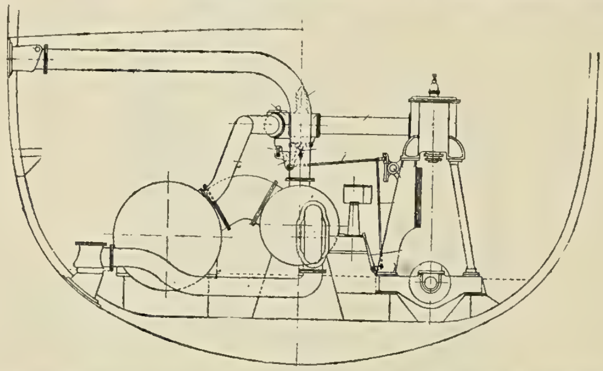
926,475. ACETYLENE-GAS BUOY. ROBERT M. DIXON, OF EAST ORANGE, N. J., ASSIGNOR TO THE SAFETY CAR HEATING & LIGHTING COMPANY, A CORPORATION OF NEW JERSEY.

Claim 4.—In a device of the nature described, in combination, a float comprising a chamber for the storage of gas, said chamber being at all times free from water, a submerged receptacle carried by said float and adapted to contain calcium carbid, a connection between said receptacle and said chamber for allowing the generated gas to pass from the former to the latter, a water inlet for said receptacle communicating with the water within which it is submerged, and automatically operating means for controlling the flow of water through said inlet. Ten claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

12,538. SHIPS' PROPELLING MACHINERY. R. R. BEVIS, BIRKENHEAD, AND J. H. GIBSON, LISCARD.

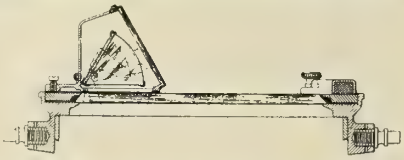
Claim.—According to this invention, the control of mixed machinery, i. e., rotary and reciprocating engines, for propelling, is effected by a single mechanism. In the example given, this is done through the agency of a link on the reversing shaft of the reciprocating engine.



The rod for actuating the reversing valves of the turbine is connected to a block sliding in this link, and by placing the block at one end of the link the rotary engines may be caused to rotate in the same direction as the reciprocating engines, or, if the block be at the other end of the link, in the opposite direction.

18,510. ATTACHMENT FOR MARINERS' COMPASSES. L. W. P. CHETWYND, KINGSTON-ON-THAMES; KELVIN & WHITE, LTD., GLASGOW, AND F. W. CLARK, GLASGOW.

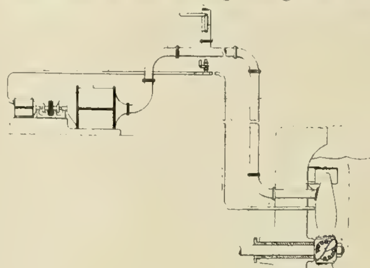
Claim.—Steering or bearing prisms are enclosed in a hood secured to the clamping ring or other part of the compass bowl. This hood is open at bottom and the prisms is mounted within upon a pivot so that it may be oscillated by means of a lever secured to its journal and ex-



tending to the exterior of the hood. Here, a segmental strip notched or indented retains the lever in any desired position. The front of the hood is covered with a glass pane, and the open bottom is surrounded by a groove for containing packing, which forms a joint with the glass of the bowl, so that the hood is inaccessible to moisture or dust.

19,047. STARTING AND REGULATING THE SPEED OF MARINE ENGINES. F. H. TANNER, HILLSIDE, STAPLE HILL ROAD, FISHPONDS, BRISTOL.

Claim.—In order to avoid difficulties in starting engines which are directly connected with the propeller, variable speed turbine compressors are employed, fitted with valves for regulating the volume and pressure



of the air or gas to be introduced into the area of action of the propeller through pipes. A shield prevents the air from escaping too readily to the surface of the water.

15,007. SIGNALING OVERHEATING OF BEARINGS. W. VOLKMER, GLEIWITZ, GERMANY.

Claim.—A block of fusible metal rests against the bearing and is carried at the top of a lever pivoted on pins. When the metal is melted by the hot bearing, the lever is rocked on its pivot by a spring, so as to release a toothed wheel and allow the clockwork to ring a bell. When the block is under the bearing, the rod must slide lengthwise, so the eccentric piece is turned to fill the slot and allow the lever to slide on the pins. The spring is then placed between caps, so that when the block melts, the spring raises the rod to release the bell mechanism.

19,446. ARMOR PLATES. M. R. RIDOLFI, FLORENCE, ITALY.

Claim.—In order to break the point of the projectile and so alter its angle and lessen its penetrative power, the case-hardened plate proper is provided with an outer hardened and toughened steel plate backed by wood. In addition to the above impediments, the projectile is further hampered by a plate, which, when pierced, forms a tough restraining collar around the nose of the projectile. A wood cushion is provided next the side of the ship.

International Marine Engineering

NOVEMBER, 1909.

THE ITALIAN BATTLESHIP ROMA.

BY DAGNINO ATTILIO.

Two first-class battleships have recently been added to the Italian navy, both built on the same general lines, but differing in certain particulars. They are the *Napoli,* built in the navy yard at Castellamare, di Stabia, and the *Roma,* built in the navy yard at Spezia. The differences are more or less minor in character, and the description will be confined to the *Roma.*

As mentioned in a previous issue, the ship has the following dimensions: Length between perpendiculars, 435 feet; length over all, 474½ feet; breadth, 73½ feet; draft, 25 feet 9 inches; displacement, 12,625 tons.

THE ROMA AT SEA. THE UPPER PART OF THE FUNNELS WILL EVENTUALLY BE CUT.

The propelling machinery of the *Roma* was built by Messrs. Ansaldo, Armstrong & Co., at their Sampierdareno works.

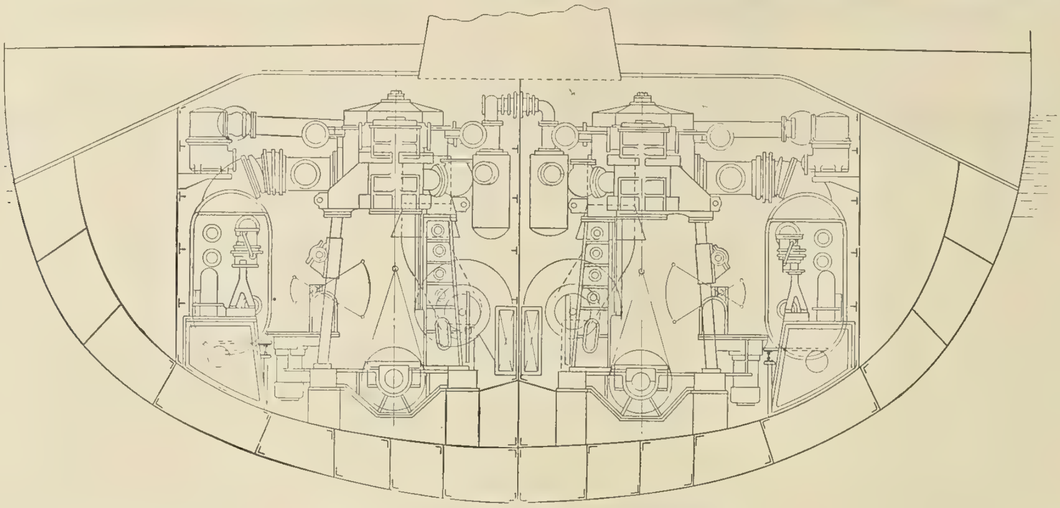
The two main engines are four-cylinder, triple-expansion engines of the vertical inverted type, balanced according to the Yarrow, Schlick, Tweedy system. They are placed in two separate compartments, divided from each other by a central bulkhead, and are designed to develop 20,000 indicated horsepower at 125 revolutions per minute, with a boiler pressure of 210 pounds per square inch.

The diameters of the high-pressure, intermediate, and of each of the two low-pressure cylinders are, respectively, 39⅜ inches, 64½ inches, and 74¾ inches. The stroke is 46 inches. All the cylinders have steam jackets. The high-pressure and intermediate-pressure cylinders have piston valves, while the low-pressure cylinders have double ported slide valves, with compensators at the back. Simple balance cylinders are fitted, both to the piston and to the slide valves. The valve gear is of Stephenson link-motion type. The reversing engine is of the all-round type. The pistons, cylinder covers, steam chest covers, bed plates, and columns are of cast steel, the pillars being of wrought steel.

The arrangement of cylinders from forward aft is: Low-pressure, high-pressure, intermediate-pressure, low-pressure. The distance between the forward low-pressure cylinder and the high-pressure cylinder is 84¼ inches; the same distance is between the intermediate and the last low-pressure cylinder, while the distance between the high and the intermediate is 163 inches.

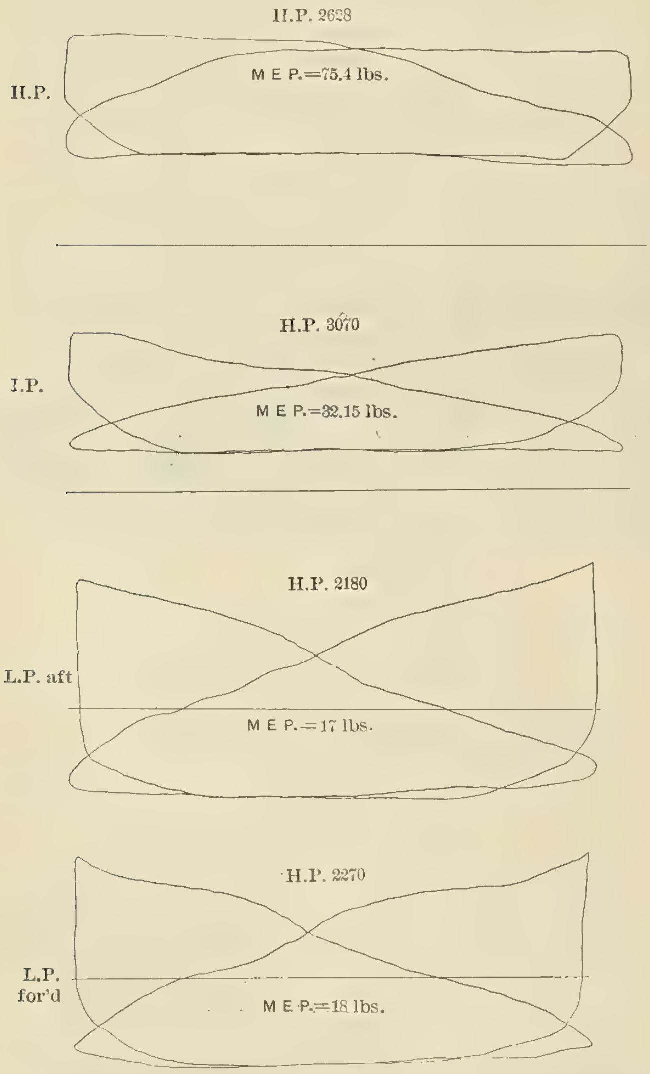
The crank shafts are of steel and hollow. Each is composed of two parts, and there are two cranks on each part. Each crank shaft has six main bearings, of 14 feet 2½ inches total length. The outside and inside diameters of the crankshafts in the bearings are, respectively, 18⅜ inches and 9⅝ inches. The diameter of the crank pins is 19 5/16 inches, and their length 22 7/16 inches. The turning wheel is fixed on the coupling at the after end of the engine.

The length of the connecting rods is 92 inches, and the minimum diameter of the solid connecting rods of the high and intermediate-pressure cylinders is 9 inches; the connecting rods of the low-pressure cylinders have the same diameter, but are hollow, the inside diameter being 5 5/16 inches. The outside diameter of the piston rods is 9 inches; the low-pressure rods are hollow, the inside diameter being 4 inches. The outside diameter of the pillars is 8 inches, and the inside diameter 4 inches. The main steam pipe is 13¾ inches in diameter, and



SECTION IN ENGINE ROOM, LOOKING FORWARD.

the diameter of the pipe between the high and intermediate-pressure cylinders is 20⅞ inches. Four 15¾-inch pipes bring steam from the intermediate-pressure cylinder to the two low-pressure cylinders. The diameter of thrust shaft is 18⅜ inches outside and 9⅝ inches inside. Each thrust shaft has eight collars, with a thrust surface of 17 square feet. The screw-shafts have a diameter of 18¾ inches. The propellers are of manganese bronze with three blades each. Their diameter is 17 feet 8½ inches; the mean pitch 20 feet 4 inches, and the developed surface 79½ square feet.



INDICATOR CARDS FROM THE ENGINES OF THE ROMA. TOTAL HORSEPOWER, 10,148; REVOLUTIONS PER MINUTE, 124.8.

There are four main condensers, two for each engine room, with a total cooling surface of 22,066 square feet. In each engine room the circulating water is supplied by two centrifugal pumps, driven by compound engines. Each pump is capable of delivering the circulating water to each of the two condensers independently or to both of them, and to draw from the bilges 1,000 tons of water per hour. There are in each engine room, also, two air pumps of the Weir type. One single air pump is also driven directly by each propelling engine from the high-pressure crosshead. There is also in each engine room an auxiliary condenser of 1,184 square feet.

The revolution counters are of the Molinari type. The other auxiliaries placed in the engine room are as follows: Two Ansaldo's evaporators complete with pumps, each capable of supplying 40 tons of fresh water during twenty-four hours; two independent bilge and fire pumps; two main, two auxiliary hot-well pumps and four fans.

There are eighteen Babcock & Wilcox watertube boilers, arranged in three compartments, situated forward of the engine room. The after and central compartments each contain six boilers of twenty-two elements, and the forward compartment six boilers of nineteen elements. The total heating surface is 56,467 square feet, and the total grate surface 1,636 square feet. There are three funnels, having a total area of 252½ square feet. The height of the funnels above the grate-bars is 95 feet.

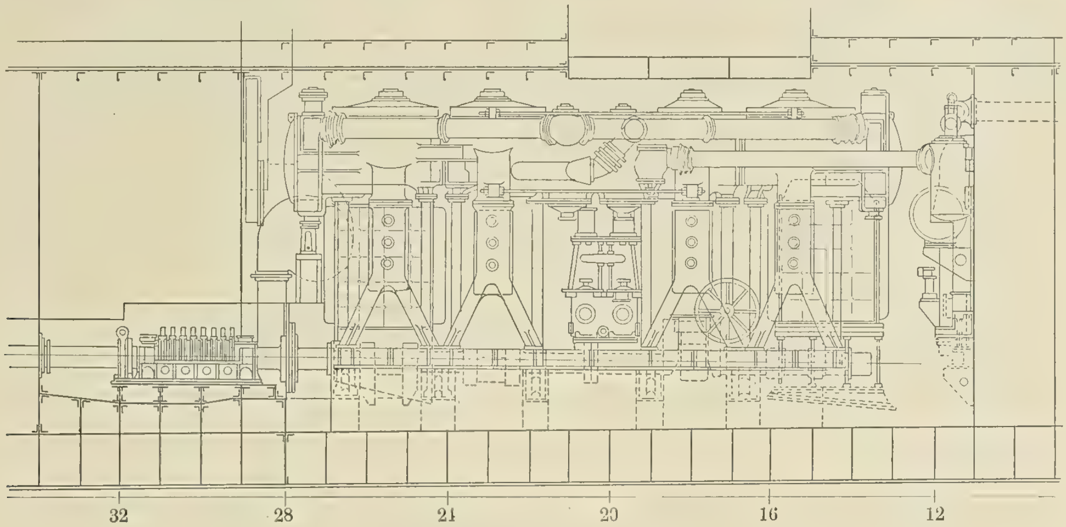
Two Weir feed pumps are placed in each boiler compartment, each being capable of supplying the water necessary for all the boilers in its compartment. Forced draft of the closed-stokehole system is obtained by means of twelve fans. There are, besides, six See ejectors with three duplex pumps for expelling the ashes, and six electrical ash hoists. The main and auxiliary steam pipes are of solid drawn steel.

The first full-power sea trial took place between Spezia and Genoa, Aug. 8. The speed measured while the ship was developing her maximum power (about 21,000 horsepower) was about 22½ knots, and the coal consumed 1½ pounds per horsepower.

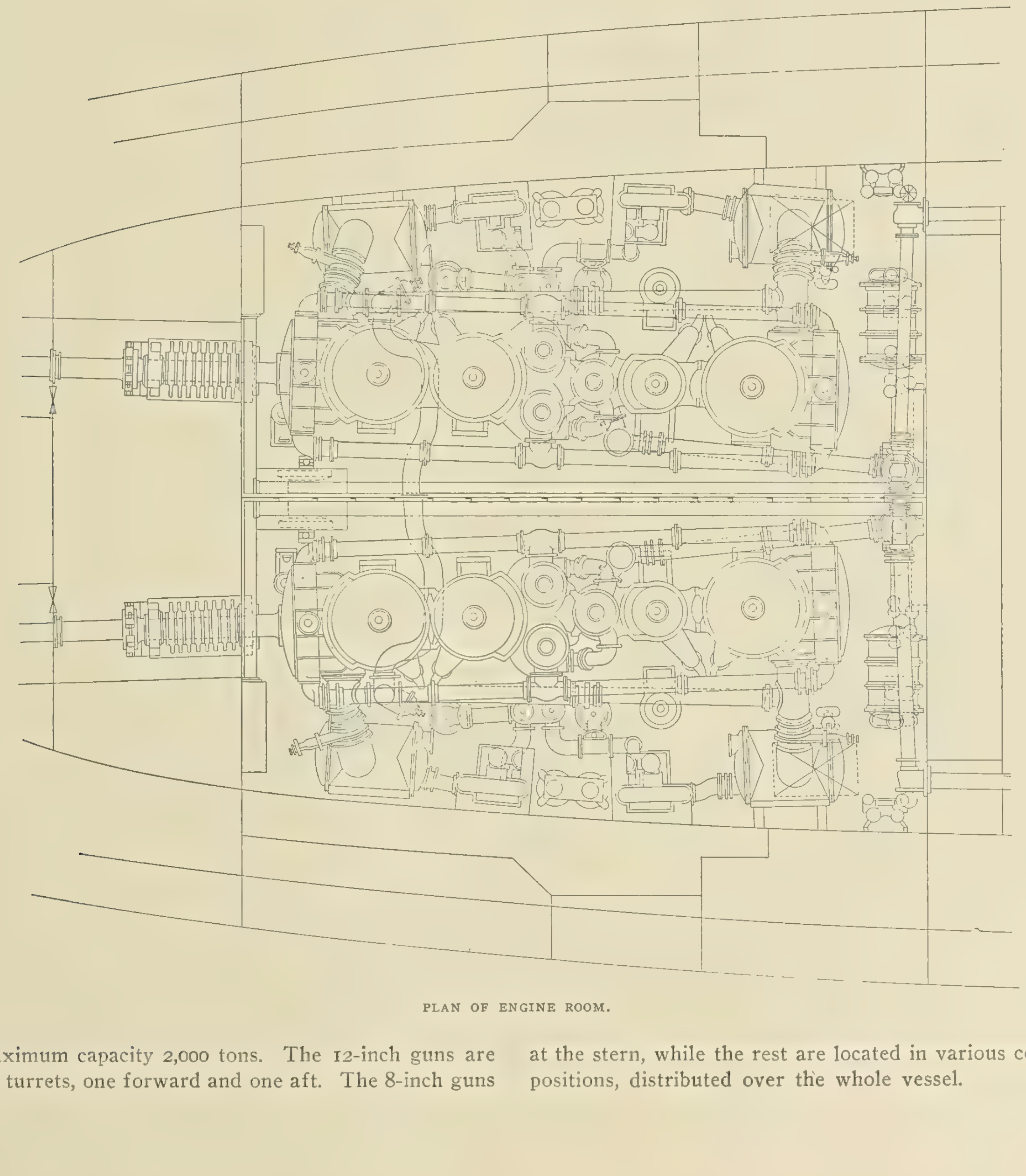
We may add that the *Roma's* hull is of steel throughout. The armor, which is face hardened, is distributed as follows: A 10-inch waterline belt, extending the length of the machinery space, tapering to 4 inches at the ends; a central redoubt of 8-inch armor, and a 3⅛-inch protective deck, worked in forward. The large turrets have 10-inch armor, and the smaller turrets 6-inch armor.

She carries two 12-inch, twelve 8-inch, eight 3⅛-inch and

twelve 1⅞-inch guns, and is provided with two submerged torpedo tubes. Her ordinary bunker capacity is 1,000 tons, are mounted in pairs in turrets amidships. Four of the 3⅛-inch guns are mounted in barbettes, two at the bow and two



SECTION THROUGH ENGINE ROOM



PLAN OF ENGINE ROOM.

and the maximum capacity 2,000 tons. The 12-inch guns are mounted in turrets, one forward and one aft. The 8-inch guns at the stern, while the rest are located in various commanding positions, distributed over the whole vessel.

THE DESIGN OF TURNING ENGINES.

BY EDWARD M. BRAGG, S. B.

POWER OF TURNING ENGINE.

The power of the turning engine must be such that the work delivered to the crank shaft of the main engine shall equal this. The quantities involved in the development and transmission of the power are as follows:

$$\frac{\pi d^2}{4} \times mep \times 2s \times n \times n_1 \times e \times e_1 \times e_2 \qquad (3)$$

where d = diameter of turning engine cylinder in inches.
mep = mean effective pressure upon the piston of the turning engine.
s = stroke of turning engine in inches.
n = number of teeth on small worm wheel.
n_1 = number of teeth on large worm wheel.
e = efficiency of small worm wheel.
e_1 = efficiency of large worm wheel.
e_2 = efficiency of turning engine.

This can be put into the form:

$$\frac{\pi d^2}{4} \times .75P \times 2s \times n \times n_1 \times .4 \times .4 \times .8 \qquad (4)$$

And when equated to (2) can be reduced to the form:

$$d^2 s = \frac{D^2 \times MEP_t \times S}{n \times n_1 \times P} \times 63.0 \qquad (5)$$

where P = initial pressure absolute at turning engine.

The force acting upon the teeth of the small worm wheel at the pitch circle will be:

$$F = .75P \times \frac{\pi d^2}{4} \times 2s \times .8 \times \frac{1}{p} \times .6 \qquad (6)$$

Where p = pitch of teeth on small worm in inches,

$$\text{Let } Z = .75P \times \frac{\pi d^2}{4} \times s \qquad (7)$$

$$\text{Then } F = .96Z \times \frac{1}{p} \qquad (8)$$

The force acting upon the teeth of the large worm wheel at the pitch circle will be:

$$F_1 = \frac{2}{3} F \times \frac{p \times n}{p_1} \times .6 \qquad (9)$$

where p_1 = pitch of teeth on large worm in inches.

$$\text{Therefore } F_1 = .384\, Z \times \frac{n}{p_1} \qquad (10)$$

The turning moment in inch pounds upon the main engine crank shaft will be:

$$M_1 = \frac{2}{3} F_1 \times \frac{n_1\, p_1}{2\pi} = .041\, Z\, n\, n_1 \qquad (11)$$

The turning moment in inch pounds upon the shaft of the large worm will be:

$$M = F \times \frac{n\, p}{2\pi} = .153\, Z\, n \qquad (12)$$

In the case of the large worm wheel whose diameter is limited by the height of the engine bed:

$$p_1 = \frac{C\, \pi\, S}{n_1} \qquad (13)$$

where C is a coefficient whose value varies from 1.1 to 1.5.

Therefore

$$F_1 = .384\, Z \times n \times n_1 \times \frac{1}{C\, \pi\, S} = .122\, Z \times n \times n_1 \times \frac{1}{C\, S} \qquad (14)$$

Since Z is a function of Pd^2s, it will be seen by referring to equation (5) that for a given engine Znn_1 is a fixed quantity, hence the force acting upon the teeth of the large wheel can be reduced only by increasing C.

If we assume that the force at the pitch circle is taken by two teeth, the stress at the root of the teeth of the small worm wheel will be:

$$f = \frac{F\, l\, 6}{2d\, t^2} = \frac{4.2\, F}{C_1\, p^2} \qquad (15)$$

Where l = length of teeth below pitch circle = .35 p.
b = breadth of teeth at root = $C_1\, p$ (C_1 varies from 2 to 2.5).
t = thickness of teeth at root, assumed to be .5 p for teeth whose thickness at the pitch circle = .48 p.

The stress at the root of the teeth of the large worm wheel will be:

$$f_1 = \frac{F_1\, l_1\, 6}{2 b_1\, t_1^2} = \frac{2.91\, F_1}{c_1\, p_1^2} \qquad (16)$$

$l_1 = .35 p_1$, $b_1 = c_1\, p_1$ where c_1 varies from 2.—2.5.
t_1 is assumed to be .6 p_1 when thickness of teeth at pitch circle = .48 p_1.

To determine the number of teeth n_1 on the large worm wheel, we have from equation (16):

$$f_1 = \frac{2.91\, F_1}{c_1\, p_1^2}, \text{ but } F_1 = \frac{.122\, Z\, n\, n_1}{C\, S}, \text{ and } p_1 = \frac{C\, \pi\, S}{n_1}$$

Therefore

$$f_1 = \frac{Z\, n\, n_1^3}{27.7\, C_1\, C^3\, S^3}, \text{ or } n\, n_1^3 = \frac{27.7\, f_1\, C_1\, C^3\, S^3}{Z}$$

$n\, n_1 = r\, m$

Therefore

$$n_1^2 = \frac{27.7\, f_1\, C_1\, C^3\, S^3}{Z\, r\, m} \qquad (17)$$

$$n = \frac{r\, m}{n_1}$$

n should not be less than 25, preferably 30.

Referring to equation (5), it will be seen that the denominator of equation (17) is a fixed quantity for a given engine [see also equations (1) and (7)], so any variation in the number of teeth, and consequently in the pitch of the large worm wheel, will have to be made by varying the stress f_1, the tooth breadth factor C_1, and the wheel diameter factor C. In short-stroke engines, where the diameter of the large worm wheel will have to be small on account of the lack of space between the shaft and inner bottom, the wheel will be rather broad and of large pitch. If possible, it is well to have the stress at the root of the teeth not more than 3,500 for cast iron and 5,000 for cast steel. In short-stroke engines the value of f_1 can be 4,000, and wheels have been designed with f_1 = 4,500. It is advisable to make the worm wheels of cast iron and the worms of steel, as these work well together and the worm has more wear on it than the wheel. If the teeth of the worm and wheel are of equal thickness at the pitch circle, the stress at the root of the worm teeth does not need to be figured, as the worm teeth will be thicker than those of the wheel. When the teeth

are of unequal thickness, the stress at the root of the worm teeth should be figured also. When the wheel is made of cast steel, the worm should be of bronze, as cast steel and wrought steel do not work well together.

CALCULATIONS.

We will design a turning gear for the engine whose calculations were carried through by the author in previous issues of INTERNATIONAL MARINE ENGINEERING in an article on "Marine Engine Design."*

Indicated horsepower = 3,000. Piston speed = 850 feet per minute. Boiler pressure = 185 gage. Cylinder sizes and stroke, 23½ inches, 41 inches, 64 inches by 42 inches. Let the main engine be turned over once in eight minutes, the turning engine making 250 revolutions per minute. Then, from equation (1), $n\,n_1 = 8 \times 250 = 2{,}000$.

From equation (5), $$d^2 s = \frac{(64)^2 \times 2.5 \times 42}{2{,}000 \times 65} = 208.$$

Let $s = 6$ inches, then $d = 5.9$ inches; use 6 inches.

The mean effective pressure of the turning engine will be $.75 \times .65 = 49$ pounds, and the area of the cylinder 28.3 square inches.

$Z = 49 \times 28.3 \times 6 = 8{,}325$-inch pounds.

We will make the worm wheel of cast iron and the worms of mild steel. Let the stress at the root of the teeth be not more than 4,000 pounds in the large worm wheel, the breadth of the wheel not more than 2.5 p_1 and the diameter of the pitch circle 1.5 S. From equation (17),

$$n_1^2 = \frac{27.7 \times 4{,}000 \times 2.5 \times (1.5)^3 \times (42)^3}{8{,}325 \times 2{,}000} = 4{,}145.$$

$n_1 = 64.4$; use 64 teeth.

$$n = \frac{2{,}000}{64} = 31.2; \text{ use 31 teeth.}$$

From equation (13),

$$p_1 = \frac{1.5\,\pi\,42}{64} = 3.085 \text{ inches; use 3.25 inches and}$$

reduce the breadth of wheel.

From equation (10),

$$F_1 = \frac{.384 \times 8{,}325 \times 31}{3.25} = 30{,}550.$$

From equation (16),

$$C_1 = \frac{2.91 \times 30{,}550}{4{,}000 \times (3.25)^2} = 2.11.$$

$2.11 \times 3.25 = 6.87$ inches; use 7 inches breadth of wheel.

From equation (16),

$$f_1 = \frac{2.91 \times 30{,}550}{2.15 \times (3.25)^2} = 3{,}920 \text{ pounds.}$$

Diameter of pitch circle of wheel $= \dfrac{64 \times 3.25}{\pi} = 66.2$ inches.

For the small worm wheel we will use a pitch of 1.75 inches and let the breadth be $2.0 \times 1.75 = 3.5$ inches.

Then from equation (8),

$$F = \frac{.96 \times 8{,}325}{1.75} = 4.570 \text{ pounds.}$$

Then from equation (15),

$$f = \frac{4.2 \times 4{,}570}{2.0 \times (1.75)^2} = 3{,}140 \text{ pounds per square inch.}$$

This wheel can be made narrower if it is desirable, as the stress is low, or the pitch could be slightly reduced. The diameter of the small worm wheel will be:

$$\frac{1.75 \times 31}{\pi} = 17.28 \text{ inches.}$$

The indicated horsepower of the turning engine will be:

$$\frac{2 \times 49 \times .5 \times 28.3 \times 250}{33{,}000} = 10.5 \text{ indicated horsepower.}$$

The mean twisting moment on the crank shaft of the turning engine will be:

$$\frac{63{,}000 \times 10.5}{250} = 2{,}650\text{-inch pounds.}$$

The maximum twisting moment will be $2 \times 2{,}650 = 5{,}300$-inch pounds.

On the assumption that the bending moment is equal to one-half the twisting moment, and that the allowable stress on the shaft is 7,500 pounds per square inch, we get for the diameter:

$$\text{Diameter} = 1.17 \times 1.72 \sqrt[3]{\frac{5{,}300}{7{,}500}} = 1.79 \text{ ins.; use 1.875 ins.}$$

The factor 1.17 was obtained from the following table given by Unwin:

$\dfrac{\text{Bending moment}}{\text{Twisting moment}}$	.25	.50	.75	1.0	1.25	1.5	1.75	2.0	3.0
Factor—	1.09	1.17	1.26	1.34	1.42	1.49	1.56	1.62	1.83

The small worm is to be keyed to the shaft so the diameter at the root of the thread $= 1.875 + 1.1 \times 1.75 = 3.80$ inches; use 3.75 inches.

Length of tooth flank $= .35 \times 1.75 = .618$ inch; use .625 inch.

Length of face $= .3 \times 1.75 = .525$ inch; use 5 inches.

Diameter of pitch circle of worm = 3.75 inches + 1.25 inches = 5 inches.

Extreme diameter of small worm = 6 inches.

$$\text{Angle of thread} = \tan^{-1} = \frac{1.75}{5\,\pi} = .1113 = 6.35 \text{ degrees.}$$

The crank shaft for the turning engine was designed to resist a twisting moment equal to twice the mean, and a bending moment equal to half the maximum twisting moment. The shaft of the large worm is not subject to such variations in twisting moment, as the fly-wheel on the crank shaft will cause this moment to be more uniform. The ratio of bending moment to twisting moment will depend upon the breadth of the wheel, and the radius of its pitch circle. In this case the half breadth of the wheel is 3.5 inches and the radius about 8.5 inches, so the bending arm will be about .5 times the twisting arm. Since the stresses are more uniform, the allowable fibre stress can be increased to 9,000 pounds.

From (12), $M = .153 \times 8{,}325 \times 31 = 39{,}460$-inch pounds. Assume the maximum twisting moment $= 39{,}460 \times 1.25 = 49{,}325$-inch pounds. Diameter of shaft =

$$1.17 \times 1.72 \sqrt[3]{\frac{49{,}325}{9{,}000}} = 3.525 \text{ inches; use 3.50 inches.}$$

Diameter of worm at root of thread $= 3.5 + 1.1 \times 3.25 = 7.075$ inches; use 7 inches.

* See INTERNATIONAL MARINE ENGINEERING, July, 1908—March, 1909.

Length of flanks = .35 × 3.25 inches = 1.14 inches; use 1.125 inches.

Length of faces = .3 × 3.25 = .975 inch; use 1.0 inch.

Pitch diameter of worm = 7 inches + 2.25 inches = 9.25 inches.

Outside diameter of worm = 9.25 inches + 2 inches = 11.25 inches.

$$\text{Angle of thread} = \tan^{-1} = \frac{3.25}{9.25\,\pi} = .112 = 6.4 \text{ degrees.}$$

The velocity of the small worm at the pitch line will be:

$$\frac{250 \times \pi \times 5}{12} = 327.4 \text{ feet per minute.}$$

The force acting normal to the teeth is 4,570; force × velocity = 4,570 × 327.4 = 1,496,218. Referring to Mr. Lewis' experiments, it will be seen that the worm will be likely to work without cutting for the short periods that the engine will run.

THE STRENGTH OF KNEES AND BRACKETS ON BEAMS AND STIFFENERS.*

BY HERMAN R. HUNT.

An examination of the midship sections of various United States naval vessels by the author showed that, in general, the depth and riveting of knees and brackets at the ends of beams and stiffeners are regulated by the depths of the beams and stiffeners, although the shapes, weights, and strength vary to a considerable extent. It was therefore thought interesting to investigate the strength of the knees and brackets at the ends of the various beams and stiffeners.

Since the case of stiffeners and beams with brackets at the ends is like that of beams with knees at the ends, we will consider in this article the case of beams supported by knees at the ends.

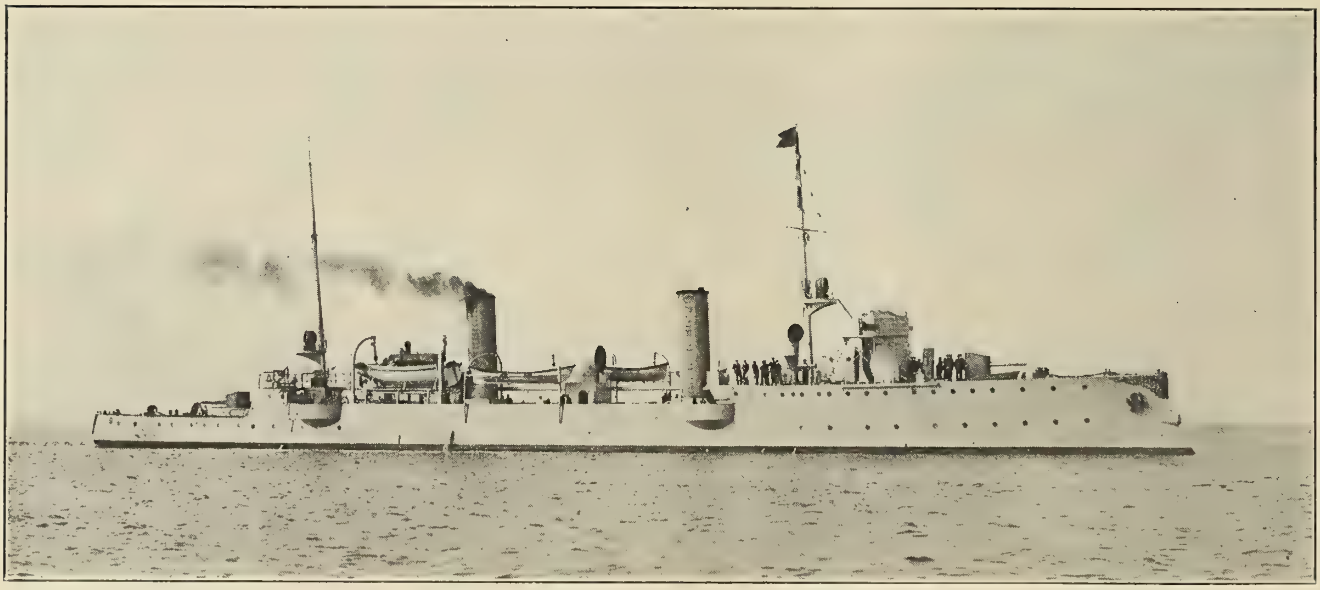
The beams and knees investigated are given in Table I. and by sketches on page 429. The riveting in the beam knees of the *Olympia, Nashville,* and *Dubuque* was assumed from the practice found in the other ships, and some of our leading shipyards, for the same sized beams. In all other respects, the data is taken from work as actually installed in the ships named.

In general, this table shows, in columns 1 to 7, that the practice in United States naval vessels is to make the depths of knees three times the depths of beams, and to use one ¾-inch rivet in the knees per inch depth of the beams. The exceptions to this statement are the 6-inch beams of the *Salem,* and the 5-inch beams of the *Vermont.* For comparison, the number and size of rivets required by Lloyd's Rules for the same knees are given in columns 8 and 9, and are determined entirely from the depths of the knees.

The strength of knees at the ends of a beam depends to a great extent on the depth and the thickness of the knees, and the number of rivets placed therein, and must be considered with reference to the strength of the beams supported.

The rivets and plating in the knees must be able to resist the shearing and crushing forces caused by loading the beam to the point of rupture. Rupture by shearing or crushing may be caused either by the concentration of a load at one

* Read before the American Society of Naval Architects and Marine Engineers, June, 1909.



22-KNOT TORPEDO CRUISER FOR THE OTTOMAN NAVY.

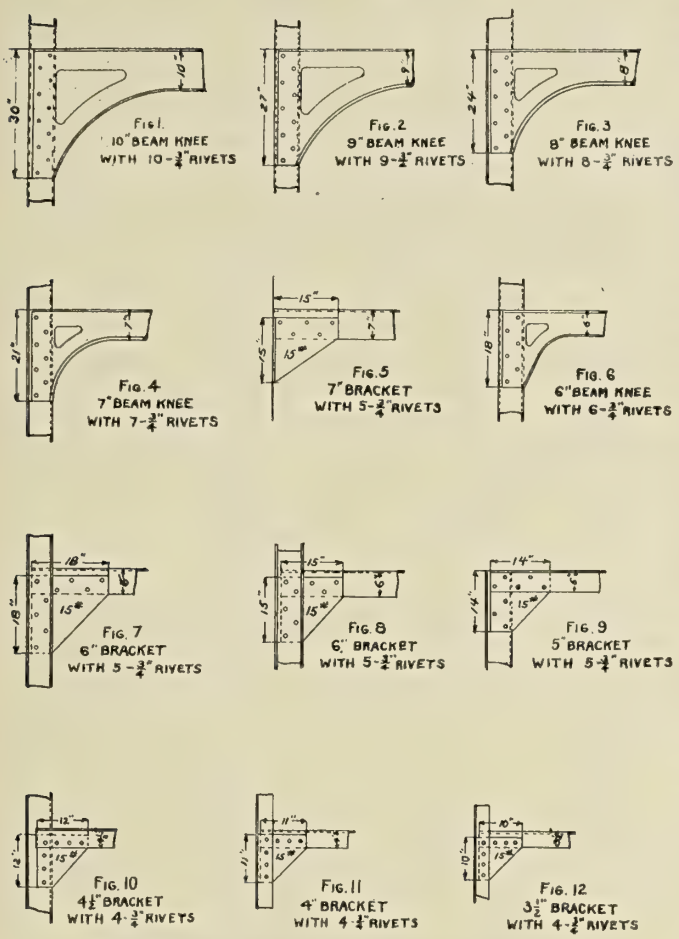
The Turkish Torpedo Cruiser Peik-i-Schevket.

The Ottoman navy has recently been augmented by a high-class torpedo cruiser, known as the *Peik-i-Schevket.* This vessel, together with her sister ship, *Berk-i-Satvet,* were built for Turkey at Kiel-Gaarten by the Fried. Krupp Aktiengesellschaft Germaniawerft. They have a gross registered tonnage of 702 tons each, and are propelled by twin screws, driven by vertical triple-expansion engines of 6,000 indicated horsepower. The principal dimensions of the hull are: Length, 262 feet 5 inches; breadth, 27 feet 6½ inches, and draft, 8 feet 2.5 inches.

The total displacement at the trial trip trim was 775 tons, and the speed attained 23 knots, or 1 knot in excess of the contract speed. The cruisers have a steaming radius of 3,240 miles, having a coal supply of 240 tons.

These new Turkish war vessels have an armament consisting of two 4.13-inch guns, also two Hotchkiss quick-firing guns, together with two 1.46-inch guns and half a dozen 2.25-inch guns. The torpedo armament includes one bow tube and two deck tubes, all for 17.7-inch torpedoes.

Both boats were laid down in 1906 and completed in 1907. The *Berk-i-Satvet* attained a speed of 23.1 knots on trial.



BEAM KNEES AND BRACKETS TAKEN FROM PRACTICE.

end of the beam or by the combination of the forces due to loading the beam between the supporting knees.

If the load is concentrated at the end of a beam, the shearing and crushing forces are uniformly distributed among the rivets, and are vertical. If the beam is loaded between the supports, the shearing and crushing forces are the resultants of the vertical forces due to the load, which are uniformly distributed among the rivets, and the horizontal forces, due to the bending moment, which are distributed among the rivets in proportion to their distance from a pole through the center of gravity of the area of all the rivets.

Columns 10, 11, and 13 of Table 1 show that, with the knees ordinarily used in the United States naval vessels, the resistance to shearing of the rivets in the majority of cases is from 60 to 80 percent of the resistance to shearing of the beams. The resistance to shearing of the rivets would therefore limit the load that could be concentrated at the end of a beam under ordinary conditions. This load is, however, large in comparison with the load that can be concentrated at the middle of the beam, even when considered with the weight of the beam itself. The deck beams of the *Vermont* are 10 inches by 3⅜ inches by 3⅜ inches by 21.8 pounds, and are allowed to have a maximum span of 18 feet between supports. Under this condition, the load which, when concentrated at the middle of the span, will rupture the beam by bending is 16.7 tons. This load added to the weight of the beam, 0.18 ton, gives a total load of 16.88 tons. From the table, column 11, we find that the rivets in one knee have a resistance to shearing of 98.6 tons, and will support a load six times as large as the total load given above.

The vertical stresses on the rivets, due to loading the beams at the middle, were found to be small when compared with the maximum horizontal stresses due to the bending moments. The resultants of the stresses, due to the loads and bending moments, were found to be but little larger than the stresses due to the bending moments alone. In the above case of the *Vermont's* deck beam, the following stresses were found:

	Due to Load, Tons per Square Inch.	Due to Bending Moment, Tons per Square Inch.	Resultant Stresses, Tons per Square Inch.
Shearing stress	1.91	18.09	18.13
Crushing stress in front of rivets	1.50	28.43	28.47

The differences between the resultant stresses in the table and the stresses due to the bending moment are less than one-half of 1 percent of the resultant stresses. Since these differences are so small, the stresses due to the loads have been neglected. The resisting moments of the beams and the riveting in the knees only have been compared.

TABLE I.—COMPARISON OF STRENGTH OF BEAMS WITH STRENGTH OF KNEES AND BRACKETS, TAKEN FROM PRACTICE.

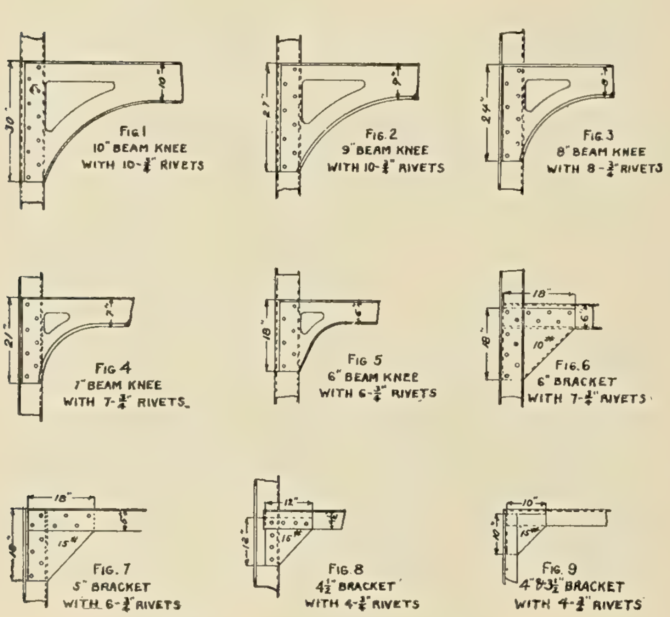
Name of Ship.	Beam: Type of Section.	Beam: Size.	Beam: Thickness.	Depth of Knee or Bracket.	Ratio = Depth Knee / Depth Beam	Number of ¾-Inch Rivets as in U. S. Navy.	Figure Number.	Rivets Required by Lloyd's: Number.	Rivets Required by Lloyd's: Diameter.	Load to Shear, Tons: Beam.	Load to Shear, Tons: Rivets, U. S. N.	Load to Shear, Tons: Rivets, Lloyd's.	Ratio = Shear Rivets / Shear Beam: U. S. N.	Ratio = Shear Rivets / Shear Beam: Lloyd's.	Bending Moment to Produce Rupture in Foot Tons: Bending Beam.	Shearing Rivets, U. S. N.	Shearing Rivets, Lloyd's.	Crushing in Front of Rivets, U. S. N.	Crushing in Front of Rivets, Lloyd's.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
*Olympia	Angle	10″×3½″×26.5 lbs	31/64″	30″	3	10	1	7	7/8″	164.8	98.6	94.0	.60	.57	535	559	571	683	598
Vermont	Channel	10″×3⅜″×3⅜×21.8 lbs	3/8″	30″	3	10	1	7	7/8″	136.4	98.6	94.0	.72	.70	453	559	571	683	598
Rhode Island	Bulb angle	9″×3½″×21.8 lbs	7/16″	27″	3	10	2	6	7/8″	134.6	98.6	80.6	.74	.60	375	498	473	710	495
Rhode Island	Bulb angle	8″×3½″×19.23 lbs	13/32″	24″	3	8	3	6	7/8″	120.1	78.8	80.6	.66	.67	290	396	406	525	425
Rhode Island	Bulb angle	7″×3″×18.25 lbs	7/16″	21″	3	7	4	5	7/8″	111.6	69.0	67.2	.62	.60	244	294	312	360	327
Vermont	Angle	7″×3½″×15 lbs	7/16″	21″	3	7	4	5	7/8″	90.8	69.0	67.2	.76	.74	133	294	312	360	327
Vermont	Channel	6″×3½″×3½″×15 lbs	0.35″	18″	3	6	5	6	3/4″	93.3	59.1	59.1	.63	.63	196	224	224	273	273
Salem	Channel	6″×1.92″×1.92″×8 lbs	0.20″	18″	3	7	6	5	3/4″	50.2	69.0	49.3	1.37	.98	106	250	191	163	125
*Nashville	Bulb angle	6″×3″×13.75 lbs	3/8″	18″	3	6	5	5	3/4″	83.9	59.1	49.3	.70	.59	158	224	191	273	234
Rhode Island	Bulb angle	6″×3″×12.3 lbs	5/16″	18″	3	6	5	5	3/4″	76.8	59.1	49.3	.77	.64	149	224	191	273	234
Rhode Island	Angle	6″×3½″×13.5 lbs	7/16″	18″	3	6	5	5	3/4″	81.2	59.1	49.3	.73	.61	101	224	191	273	234
Vermont	Angle	5″×3″×9.8 lbs	3/8″	18″	3 6/10	6	7	5	3/4″	57.6	59.1	49.3	1.03	.85	60	224	191	273	234
Des Moines	Angle	4½″×3″×9.1 lbs	3/8″	12″	2 2/3	4	8	4	3/4″	53.3	39.7	39.7	.75	.75	49	99	99	121	121
*Dubuque	Angle	4″×3″×8.5 lbs	3/8″	10″	2 1/2	4	9	4	3/4″	49.1	39.7	39.7	.81	.81	39	78	78	90	90
*Dubuque	Angle	3½″×3″×6.6 lbs	5/16″	10″	2 6/7	4	9	4	3/4″	38.6	39.7	39.7	1.03	1.03	26	78	78	90	90

* Number of rivets assumed from practice on U. S. Naval vessels.

Continuation of Table I.

Name of Ship.	Ratio = Riveting Moment / Beam Moment: Shearing, U. S. N.	Shearing, Lloyd's.	Crushing, U. S. N.	Crushing, Lloyd's.
	20	21	22	23
*Olympia	1.05	1.07	1.28	1.12
Vermont	1.23	1.26	1.57	1.37
Rhode Island	1.33	1.26	1.89	1.32
Rhode Island	1.37	1.40	1.81	1.47
Rhode Island	1.21	1.28	1.48	1.34
Vermont	2.21	2.35	2.71	2.46
Vermont	1.14	1.14	1.39	1.39
Salem	2.36	1.80	1.62	1.18
*Nashville	1.42	1.21	1.73	1.48
Rhode Island	1.50	1.28	1.83	1.57
Rhode Island	2.21	1.89	2.70	2.32
Vermont	3.77	3.18	4.55	3.90
Des Moines	2.02	2.02	2.47	2.47
*Dubuque	2.00	2.00	2.31	2.31
*Dubuque	3.00	3.00	3.46	3.46

* Number of rivets assumed from practice on U. S. Naval vessels.



BEAM KNEES AND BRACKETS RECOMMENDED.

The resisting moments of the beams were calculated without taking into account the deck plating riveted to the beams, but considering one ¾-inch rivet hole in the shorter flanges at the sections of the beams. The deck plating was omitted because of the wide variation of thickness used on the same beam under different conditions.

Columns 15, 16 and 18 of Table I. give the moments required to rupture the beams and cause failure of the riveting by shearing or crushing of the metal. For comparison, the moments that will cause failure of the riveting required by Lloyd's Rules for the same knees are also given in columns 17 and 19 of the same table. These moments were calculated by the formula $f = \frac{My}{I}$, where f equals 63,000 pounds per square inch tensile stress, 50,000 pounds per square inch shearing stress, and 96,000 pounds per square inch crushing stress, and are expressed in foot-tons. The moment of inertia of the rivets in every knee has been taken about a pole through the center of gravity of the area of all the rivets in the knee.

Columns 16, 17, 18 and 19, show that the riveting of beam knees as required by Lloyd's Rules gives approximately the same resistance as the riveting according to the ordinary practice in United States naval vessels. In general, however, the riveting for knees having a greater depth than 18 inches, as required by Lloyd's Rules, is slightly stronger than that used in United States naval vessels, and the riveting for knees having a depth of 18 inches and less, as required by Lloyd's Rules, is somewhat weaker than that used in United States naval vessels. If we exclude the last four beams and the protective deck beam of the *Olympia,* the resisting moments of the riveting have a ratio to the resisting moments of the respective beams varying from 1.14 to 2.21 for United States naval vessels, and .97 to 2.35 for Lloyd's Rules in the case of shearing, and from 1.48 to 2.71 for United States naval vessels, and 1.18 to 2.46 for Lloyd's Rules in the case of crushing the metal in front of the rivets. The largest ratios occurred in the 7-inch and 6-inch angle bars.

The variations in the above ratio appear too large. It seems more logical to design the riveting and depth of knee in such a way that the ratio of the resisting moments of the rivets to the resisting moment of the beam shall be kept between more narrow limits. It is recommended that these limits be made 1.20 and 1.60 for shearing, and 1.30 and 1.80 for crushing the

TABLE II.—COMPARISON OF STRENGTH OF BEAMS WITH STRENGHTH OF KNEES AND BRACKETS RECOMMENDED FOR USE.

Beam: Type of Section.	Beam: Size.	Beam: Thickness.	Depth of Knee or Bracket.	Ratio = Depth Knee / Depth Beam.	No. of ¾" Rivets.	Figure No.	Load to Shear. Tons: Beam.	Load to Shear. Tons: Rivets.	Ratio = Shear Rivets / Shear Beam.	Bending Moment to Produce Rupture-Ft. Tons: Bending Beam.	Shearing Rivets.	Crushing in Front of Rivets.	Ratio = Rivet Mom. / Beam Mom.: Shearing.	Crushing.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bulb angle	10″×3½″×26.5 lbs.	31/64″	33″	3.3	11	..	164.8	108.5	.66	535	661	751	1.24	1.40
Channel	10″×3⅜″×3⅜″×21.8 lbs.	3/8″	30″	3	10	1	136.4	98.6	.72	453	559	683	1.23	1.57
* Channel	9″×3½″×3½″×20.5 lbs.	3/8″	27″	3	9	2	127.0	88.8	.70	388	457	558	1.18	1.44
Bulb angle	9″×3½″×21.8 lbs.	7/16″	27″	3	9	2	134.6	88.8	.65	375	457	651	1.22	1.74
*Channel	8″×3½″×3½″×18.7 lbs.	3/8″	24″	3	8	3	116.0	78.8	.68	319	396	485	1.24	1.52
Bulb angle	8″×3½″×19.23 lbs.	13/32″	24″	3	8	3	120.0	78.8	.66	290	396	525	1.37	1.81
*Channel	7″×3½″×3½″×17.0 lbs.	3/8″	21″	3	7	4	106.0	69.0	.65	254	294	309	1.16	1.22
Bulb angle	7″×3½″×18.25 lbs.	7/16″	21″	3	7	4	111.6	69.0	.62	244	294	360	1.21	1.48
Angle	7″×3½″×15 lbs.	7/16″	15″	2 1/7	5	5	90.8	49.3	.54	133	158	226	1.19	1.70
Channel	6″×3½″×3½″×15 lbs.	0.35″	18″	3	6	6	93.3	59.1	.63	196	224	273	1.14	1.39
Bulb angle	6″×3″×13.75 lbs.	3/8″	18″	3	5	7	83.9	49.3	.59	158	191	244	1.21	1.54
Bulb angle	6″×3″×12.3 lbs.	5/16″	18″	3	5	7	76.8	49.3	.64	149	191	203	1.28	1.36
Angle	6″×3½″×13.5 lbs.	7/16″	15″	2½	5	8	81.2	49.3	.61	101	158	226	1.56	2.24
* Channel	5″×3″×3″×12.6 lbs.	3/8″	16″	3 1/5	5	..	77.2	49.3	.64	126	168	208	1.33	1.65
Angle	5″×3″×9.8 lbs.	3/8″	14″	2 4/5	5	9	57.6	49.3	.85	60	144	177	2.40	2.95
Angle	4½″×3″×9.1 lbs.	3/8″	12″	2 2/3	4	10	53.3	39.7	.75	49	99	121	2.02	2.47
Angle	4″×3″×8 lbs.	3/8″	11″	2 3/4	4	11	49.1	39.7	.81	39	88	103	2.26	2.64
Angle	3½″×3″×6.6 lbs.	5/16″	10″	2 6/7	4	12	38.6	39.7	1.03	26	78	90	3.00	3.46

* Proposed new shapes.

metal in front of the rivets in the knees of all beams deeper than 5 inches. For beams 5 inches in depth and less, it is recommended that sufficient rivets be used to close the joint efficiently without fixing the maximum value of the above ratios.

Table II. and the sketches on page 430 have been prepared in accordance with the above recommendations. The desired ratios of resisting moments have been obtained by varying the depth of the knees or the number of rivets. In this table ¾-inch rivets have been used for all beam knees, but, had any beam been of a thickness outside of the limits requiring ¾-inch rivets, it would have been necessary to use rivets of appropriate diameter for that thickness, and modify the number of rivets in order to keep the ratios of the resisting moments of the riveting to the resisting moment of the beam within the prescribed limits.

These results hold good for both knees and brackets used on either beams or stiffeners.

In the case of brackets, the rivets should be so disposed that the brackets will be equally strong along both riveted sides.

The comparison between the resistances of a beam subjected to bending and the shearing of the rivets in its knees by twisting was originally done under the direction of Professor W. Hovgaard for use in the instruction of the assistant naval constructors at the Massachusetts Institute of Technology. The results of this comparison convinced the author that they would be of interest to this society. He therefore investigated the resistance of the metal to crushing in front of the rivets. The tables therefore show a comparison between the resistance of the beam and the resistance of the riveting in the beam knees to shearing and crushing of the metal in front of the rivets, when the whole beam is subject to bending.

MACHINERY AND PIPING ARRANGEMENTS ON BOARD SHIP—I.

BY JOHN M'COLL.

THE BOILER ROOM.

The machinery arrangement, in connection with a vessel to be built, is usually the first drawing made by the engineers. It deals with the position and relation of the engines and boilers to the ship; with hatches, casings, bunkers and watertight doors; with the position of the funnel or funnels, screen bulkheads and entrances, etc. This drawing is made to a scale of ¼ inch to the foot, and should be as complete as possible. Such parts as boiler stools, angles for platforms and gratings, strong beams and air screens, can be shown in detail, and should be given to the shipbuilders, thus avoiding the giving of separate detailed drawings later.

In beginning an arrangement drawing the specification should be read over very carefully. Some specifications leave no doubt as to what is required, but should the information given be meagre, or open to question, notes should be taken of each item, and these so arranged that they may be submitted to the superintendent at the first opportunity. If the job in hand is in some respects similar to others already completed, and if the items in question can be settled by the manager, it will be a help to make a list headed as shown, filling in under the different engine numbers what has been done in each case.

Items.	No. 241.	No. 260.	No. 273.	New No.
Feed pipes.	Copper.	Copper.	Steel.	....

The usual drawings supplied by the shipbuilders, on which to start the work, are a profile from the machinery space aft to the rudder post, and one or two sections. If the engines are near the stern, or if the ship fines quickly in way of the engines, more sections will be required, especially should there be many auxiliaries in the engine room.

In general, the engines and boilers should be close together, so that the steam, feed water and other connections may be short, and the supervision of the stokehold simplified. Their relative positions, however, depend on many things, such as the position and capacity of the coal bunkers, watertight bulkheads, and the ship's accommodation. In high-powered ships the position of the center of gravity of the machinery, fore and aft, and vertically, is important; especially is this so in the case of fast coasting or channel steamers, torpedo-boat destroyers and cruisers.

Divide, for convenience, the machinery arrangement into two parts, the engine room and boiler room, and begin with the boiler room. The ship designers usually fix provisionally the position of the bulkheads containing the machinery space. The width of hatches and casings may also be fixed, but these can generally be modified to suit the arrangement. In ships requiring much accommodation, the designers naturally wish to use all the space they can possibly utilize; on the other hand, the engineers must see that they have sufficient room for the proper working and maintenance of their part of the ship. In cargo vessels the engineer can generally get the required room easily, but in passenger steamers he has to have good reasons for the space he occupies.

Beginning with a simple case, that of a ship with one or two boilers, the arrangement may be as that shown in Fig. 1. The boiler is fired from the forward end and has a dust-tight screen at the aft end, round it, and extending across to the ship's sides. The advantages of this position are that the back end of the boiler is in the engine room, allowing nearly all of the boiler mountings to be placed there, the engine room is kept free from dust and grit, and the bunker doors placed so as to minimize the trimming required. In fixing the distance from the bulkhead to the front of the boiler, theories may vary as to the suitable distance for a fireman to work in; but as tubes have sometimes to be renewed, it is necessary that the distance be not less than the length of the tubes. It will be found that an allowance of 9 inches over the length of tubes will satisfy ordinary requirements. The height from the floors to the underside of the boiler may vary from 3 inches in ships with no water ballast to 2 feet in ships with water ballast. In the former case it is usually the height of the deck over the boilers that keeps them low. In ordinary cases, if possible, the distance should not be less than 12 inches, so that proper care may be given to both the underside of the boilers and the tank top.

The boiler stools may be built of plates and angles, as shown in Fig. 2, or of cast iron, as in Fig. 3. The former are preferable, as they become part of the ship's structure, can be better stayed, and are lighter. Stools should be placed directly over the floors and, if this is not possible, as in the case of some double-ended boilers, a bridge piece connecting the two floors between which they rest should be fitted. Tie plates, in ships with shallow floors, should be arranged to distribute the weight of boilers over as many floors as possible, and in ships with ballast tanks the tie plates should not prevent access to the bottom of the boilers.

Pitching chocks to prevent movement fore and aft will be required, and these are best placed at the forward and aft ends. They should span two floors, and be well secured to the tank top with heavy angles. Heavy plates ¾ to 1 inch thick should be used; and for large boilers, doubling pieces to broaden the bearing surface, as shown in Fig. 4, will be an advantage. Should the height of boilers exceed 15 inches, the chocks should have a side stay. Angles for stools and pitching chocks should be riveted to the tank top early, so that the tank testing is not interfered with.

To keep the boilers in place when the ship is rolling much,

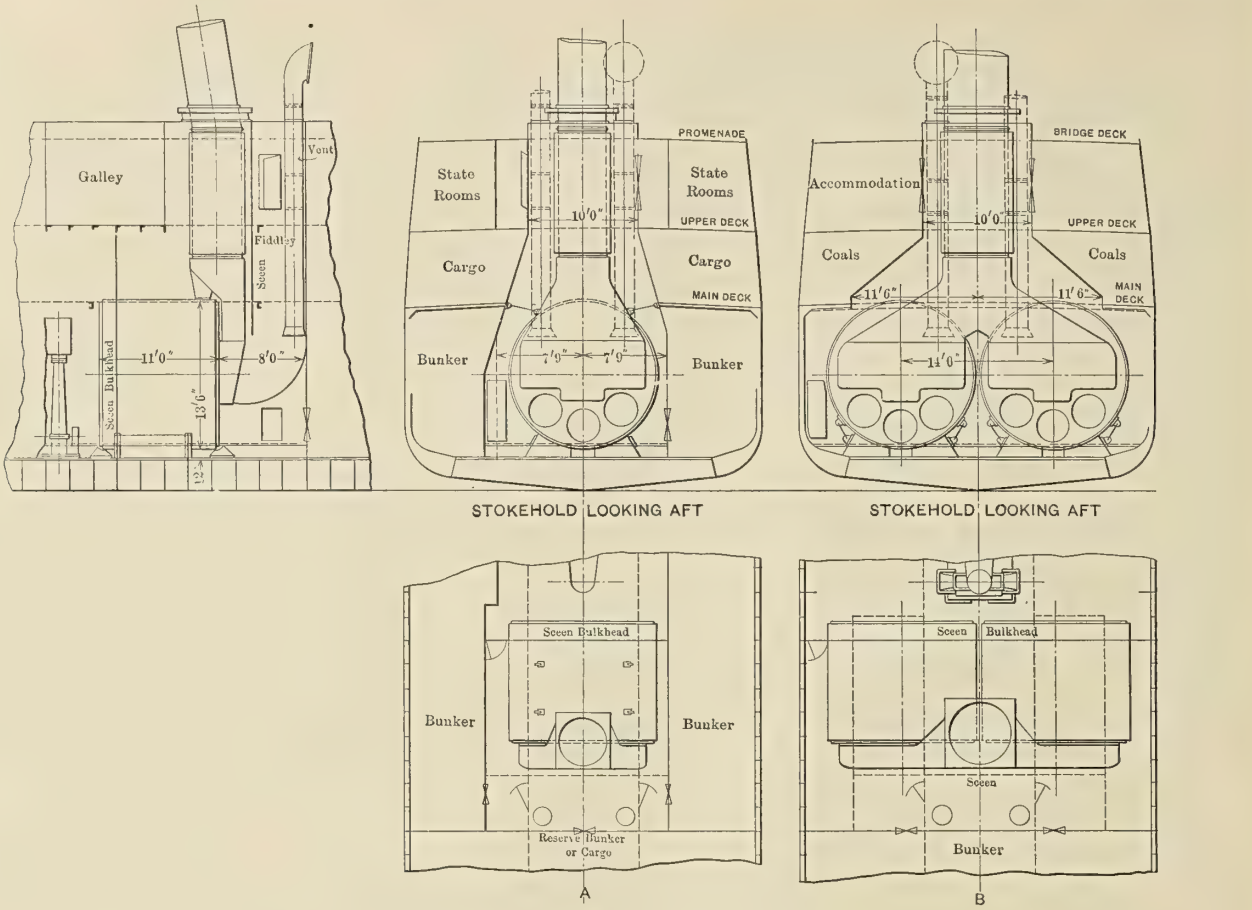


FIG. 1.

two methods may be adopted; first, that of bar stays and palms, as in Fig. 5; one palm is riveted to the boiler, the other to some rigid part of the ship, usually the deck coaming plate, as in Fig. 1A, or to the boiler stools, as in Fig. 1B. In Fig. 1B the stays need not be round bars with forked ends, but could be cut from plate, say, 1 inch thick by 4 inches broad, doubled. Another method to prevent movement is that

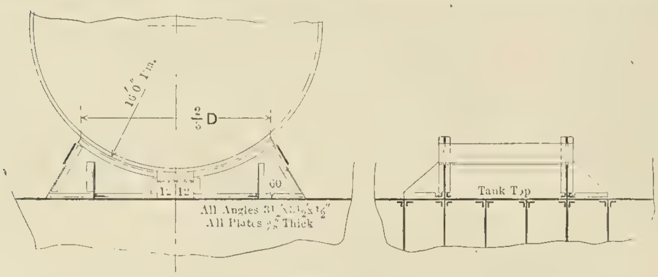


FIG. 2.

shown in Fig. 6. Care in this case must be taken to sufficiently stiffen the bunker side.

In arrangements with two or three boilers abreast, the distance between each will depend on whether the passage from engine room to stokehold, or stokehold to stokehold, is to be

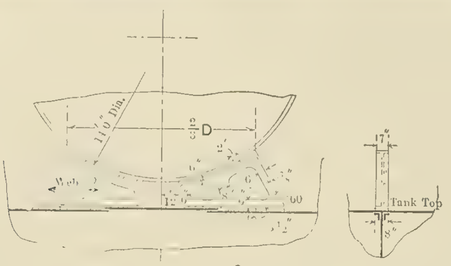


FIG. 3.

between the boilers or at the ship's side. If the passage is at the side, the distance between boilers should be at least sufficient so that each can be properly lagged; but if the boilers are required to be very close together, the butt straps can be kept out of the way, and the rivets in the circumferential seams at the center line countersunk. In any case the passage should be large enough to allow a man to pass through upright; and if possible, it should be on the same side as the engine starting platform.

In fixing the distance between boilers facing each other, whether single or double-ended, the ventilators, air trunks (if forced draft), the position, and means of access to the gage glasses and other mountings, all have to be considered, and

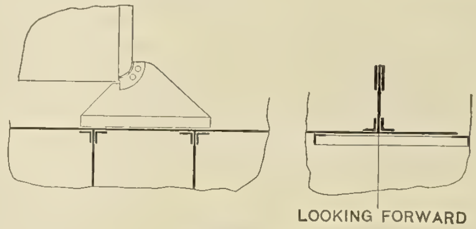


FIG. 4.

as these vary in each ship, a set distance is not easily fixed. However, it is found that from 11 to 13 feet between boiler fronts gives a fair stokehold. In placing single-ended boilers with their backs to each other, or to a bulkhead, room should be left sufficient to allow a man in to do slight repairs. If back to back, as in Fig. 7, the distance should not be less than 18 inches, as, with about 3 inches covering on each, the space would then be 12 inches. If the back end is next a bulkhead, the same distance should be maintained, to allow for bulkhead stiffeners.

Auxiliary boilers, whether connected or not to the main steam system, should, if convenient, be placed at the aft end of the stokehold, so that they may be near the pumps, etc. In other respects they are dealt with as main boilers. If used for winches only, they are sometimes placed on the same deck as the winches, and between the engine and funnel hatches.

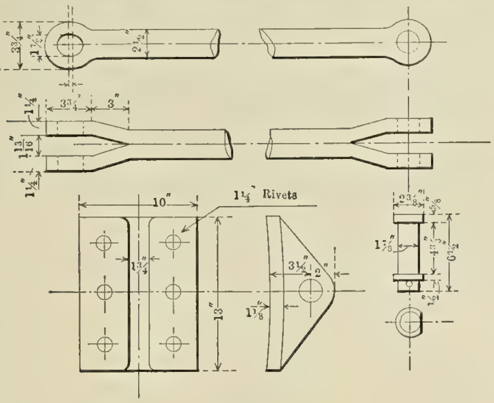


FIG. 5.

In this case, the deck supporting them has to be specially strengthened, and, owing to their elevation, extra precautions are required to prevent them breaking loose in rough weather.

As the arrangement of bunkers and casings depends so much on the type of ship, only general statements can be made here. With the boilers placed alongside a bunker, the minimum distance between them should be 9 inches. With a cross bunker between the engine and boiler rooms, passages are required for communication and for steam pipes. Should the main passage not be used as a recess for auxiliaries, its width should not be less than 36 inches, and, if fitted with a watertight door, it should also have a wood door.

When the boilers are surrounded by bunkers, recesses or passages to the ship's sides are required for the blowoff cocks, firemen's water-service cocks, and the ash ejector pump and sea suction valve. One frame space is usually sufficient for these recesses, and the height need not be more than necessary to give access to the cocks and valves.

In arranging the boiler casings, the engineer's first care should be to provide sufficient room for the boiler mountings, main and auxiliary steam pipes, etc., and to see that these are readily accessible. If the fiddleys are to give access to the stokeholds, they must be large enough to admit the use of sloping ladders, and care should be taken to see that the ventilators and fan trunks, if any, do not block the natural air

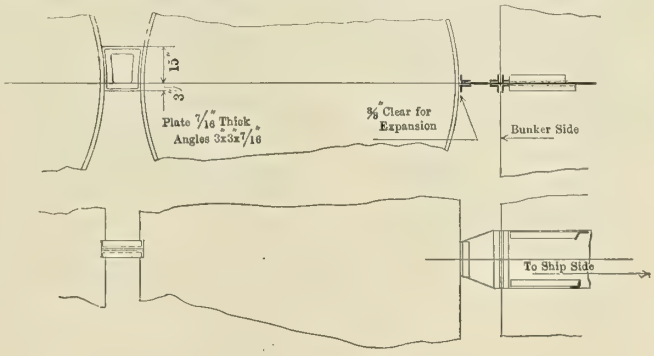


FIG. 6.

supply to the stokeholds. If the outer funnel only is to be supported by the casings, as in Fig. 7, bracket plates are fitted, and if the whole funnel is to be supported, as in the largest vessels, the arrangement may be similar to that shown in Fig. 8. In the latter case, the inner funnel has a simple sliding joint as its base, the lowest tier of riding plates between the funnels being riveted to both, and the remainder to the inner funnel only. This allows for the different expansions. The outer funnel brackets rest on the casing, strong beams and brackets taking the whole weight off the smoke-boxes and boilers. The screen bulkheads, or air screens, should be carried down as far as possible, to prevent the tendency of the air supply to make a short circuit instead of going to the furnaces.

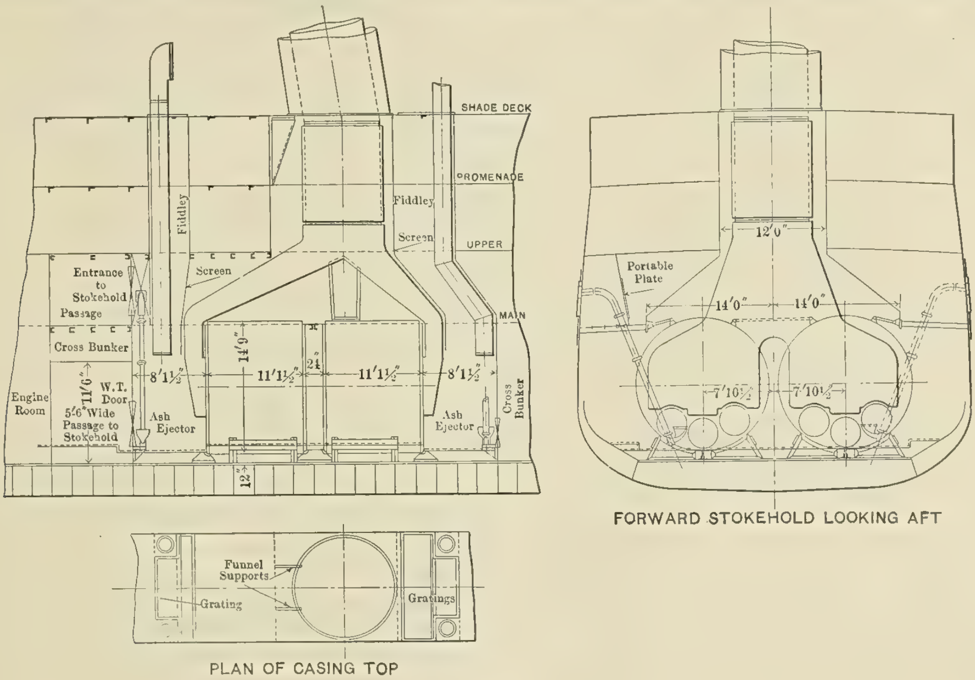


FIG. 7.

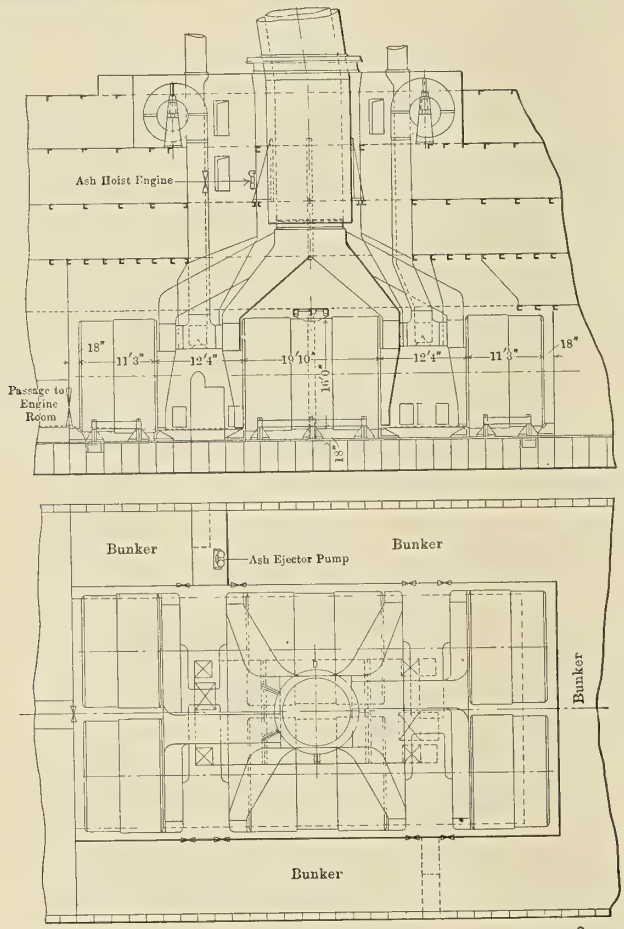
The position of the fans for assisted draft is usually at the fiddley top, with air trunks led into the ventilators. For forced draft the fans may be at the top or bottom of the fiddley. At the top their supply of air is right, but long trunks are required to reach the boilers. They are too much out of the way of the engineers, and, if they make any noise or cause vibration, they may be a source of complaint from the passengers. At the bottom of the fiddley, they are near their

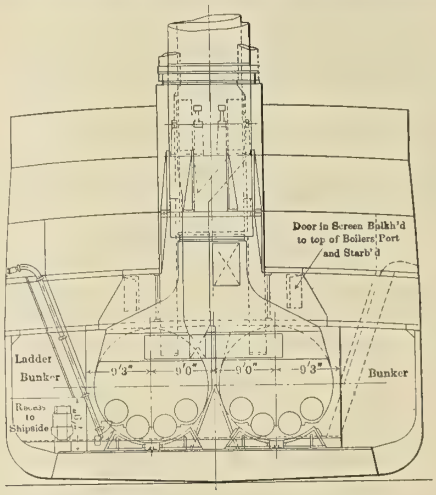
work, easily attended to, and out of the way of passenger accommodations. Proper seating and heavier scantlings can also be used here, and vibration will be avoided; on the other hand, unless enclosed, they will get their share of the stokehold dust and grit.

In closed stokehold arrangements, the fans are placed on the deck above the boilers, and the type of fan will determine whether they project through the deck or not. Fig. 9 shows an arrangement suitable for a fast coasting steamer. The difficulties with this type of ship are the lack of roof available, the smoke-boxes are crushed down, making the angles so flat that soot is allowed to lie and gets burned, causing the plates to be unduly heated. The passages to the fan rooms are awkward, and the principal boiler mountings are practically outside the stokehold.

The angle of the underside of the smoke-boxes should not be less than 35 to 37 degrees, and there should be no flat parts. supply, so that these must be ample to meet this requirement. They should be carried down to about 8 feet from the stokehold floor and, if the lower ends foul the smoke-box doors when open, may be made to telescope, or hinge out of the way. If used as ash hoists, they should be bell-mouthed and fitted with wood runners. For ordinary requirements the cowl diameter is twice that of the body. The thickness of body is from 14 to 12 L. S. W. G., and the cowl from 12 to 10 L. S. W. G.

Unless in the largest ships, where the boilers may be at a distance from the engine room, it is not necessary to provide for feed pumps in the stokeholds. The ash ejector pump, however, is suitably placed there and, if convenient, the recess for blow-off cocks may be enlarged to receive it. The number of ejectors will be fixed by the specification, but they should be placed equally on both sides of the ship. The segments at the top must be accessible from the stokeholds or at





AFT STOKEHOLD LOOKING FORWARD

FIG. 8.

The smoke-box should be supported from the boilers, not by beams or the casings. If there is more than one boiler, the smoke-box area for each should be a little more than its share of the funnel. The inner funnel area may be one-fifth the total grate area. The diameter and height of the outer funnels are usually made to suit the appearance of the ship. If the funnel is not to be double, an air casing should be fitted up to where it commences to rake aft, and should be 6 to 8 inches greater in diameter. The lower part of the breakwater should suit the hole in the casing top, and may be 9 inches clear of the funnel all around, the upper part projecting at least 3 inches beyond, and being attached to the funnel.

The fiddley top is filled in with grating, except for as much as will support the ventilators. In very heavy weather the grating may be covered over with canvas or sheet-steel plates. The ventilators would then be the only source of natural air the place for changing and renewing these, and for attending to the valve. The means for getting there will vary, but two ways are shown in Figs. 7 and 8.

The ash-hoist engines are placed high up in the fiddley and, if no ash chute is fitted, they should be at a deck where there is easy access to the ship's side for tipping the ashes overboard.

Ladders and gratings ought to be arranged to give the easiest passage to the parts requiring them. Vertical ladders should be avoided, and it is better to have shorter ladders with landings than very long ladders. The usual width of stokehold ladders is 18 inches, and the main ones should be double sparred. The gratings vary in width to suit their positions; but where single-width gratings are used, these should not be less than 18 inches broad.

(*To be continued.*)

PROPER METHODS OF OPERATING AND CARING FOR A YARROW WATERTUBE BOILER IN ORDER TO GET THE GREATEST EFFICIENCY.

In considering the subject of the relative merits of Scotch and watertube boilers, the fact is frequently stated that the watertube boiler requires excessive coal consumption. Whenever this is true, it is due largely to mismanagement of the boiler, rather than to any inherent fault of the boiler itself. Excessive coal consumption of watertube boilers is usually due to the fact that too little coal has been consumed per square foot of grate surface. The elasticity of construction of the watertube boiler makes it fully able to stand forcing, and, therefore, greater efficiency and economy are likely to be obtained by burning, say, 40 pounds of coal per square foot of grate area in a few boilers than by using 20 or 30 pounds per square foot on a much larger grate area. Undoubtedly it is easier work for the stokers to use a greater number of boilers and to run them without forcing, but, where this is done, it is extremely likely that uniform firing will not be carried on, and that holes in the fires will be found, through which the cold air will enter, thus producing incomplete combustion and causing undue loss of heat.

In an ordinary Scotch boiler, each furnace has only about 21 square feet of grate surface, and, therefore, it is not a difficult matter for an ordinary fireman to keep the grate completely covered with coal. On the other hand, in many watertube boilers 50 or 60 square feet of grate surface are frequently included in a single furnace. To fire such a furnace, which is usually from 7 to 8 feet long, requires, not only considerable skill, but it necessitates conscientious work. Right here is where much of the inefficiency which has been laid to the fault of the watertube boilers really exists. Until stoking in watertube boilers is carried out as efficiently as it usually is in Scotch boilers, it is impossible to obtain like results. The need of a training school for stokers for such boilers is very urgent.

The reason for burning a large amount of coal, rather than a small quantity per square foot of grate area, is because combustion is more complete when rapid. The temperature of the furnace is also maintained at a higher point, thus insuring complete combustion before the gases pass through the tubes. It is true that in some designs of watertube boilers, slow combustion may be necessary, because in such designs, if the rate of combustion is very high, the heat absorbed by the lower row of horizontal tubes may be too great for the capacity of the tubes for generating steam, consequently the tubes are liable to become overheated and rupture. In the case of the Yarrow boiler, however, this possibility does not exist, owing to the inclined tubes, which permit the steam to pass rapidly to the steam drum, thereby setting up automatically a vigorous circulation. This circulation is enhanced by ample downcasts, and, therefore, practically the only thing which can cause overheating of the tubes is the obstruction of some tube, which, of course, would not be likely to happen if the boiler were properly cleaned and inspected.

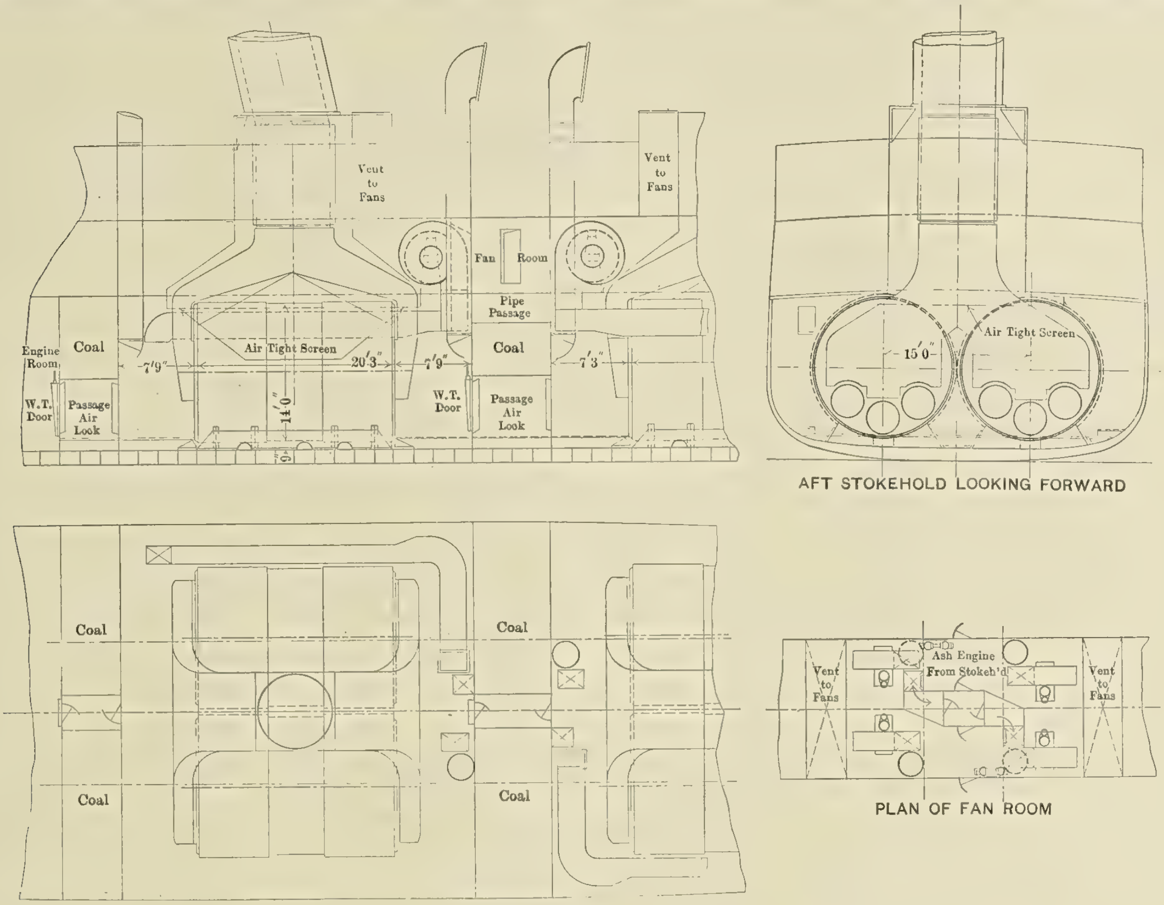


FIG. 9.

With proper firing, the coal consumption of the Yarrow boiler can be made highly satisfactory. The main reason why good economy can be obtained with this type of boiler is because the combustion chamber is large, permitting an intimate and proper mixture of air with the gaseous carbon and giving time for complete combustion of the gases before they pass among the tubes.

RENEWAL OF TUBES.

The replacing of tubes in the Yarrow boiler is a matter that can be very easily carried out, and any defective tube can be removed and replaced in a few hours without disturbing the

boiler. It is, of course, most important to be able to clean readily the outside of the tubes in any watertube boiler, since deposits of soot and dirt soon decrease the efficiency of the heating surface. The tubes of the Yarrow boiler can be cleaned in three directions: from the front between the tubes, from the furnace, or from the casing outside. Furthermore, since the tubes are all straight, with the possible exception of the two rows next the fire, which are sometimes slightly bent, the tubes can be examined internally throughout their entire length. This can be carried out most conveniently by means of a small electric light, which can be passed through the tubes, giving an opportunity for careful examination of the interior surfaces from the mud drums to the steam chest.

In the event of renewing tubes, the question of spare gear is not a vexatious one for the engineer, since the tubes are all of uniform diameter.

The tubes are secured to the tube plates by the usual expanded joint, which has stood the test of time as practically the best joint which can be made in a boiler shop. Leakage can be practically overcome if the tubes are properly expanded. The end of the tube should project through the plate for a length of about 3/16 inch. This projecting end should then be turned over to an angle of 45 degrees. This can be done by means of a special forming tool, the operation being called "bell-mouthing." If a tube should split in belling, it should at once be rejected as unfit for service. Great importance is attached to the bell-mouthing, and it has been found that tubes thus securely attached to the plate cannot creep, or in any way move in the tube holes.

INSTRUCTIONS FOR LAYING UP THE BOILER.

When laying up a Yarrow boiler, it is advisable that it should be emptied and drained of water and thoroughly washed out internally with clean, fresh water. Ashes and any accumulation of soot should be removed from the tubes and tube plates. This is of the utmost importance, because if moisture becomes absorbed by the dirt which collects on the heating surface, corrosion will soon commence, and when once started will increase rapidly. The outside of the tubes may then be cleaned by means of a hose with as good a force of fresh water as is available. The casing should also be carefully swept on the inside.

To dry out the boiler a small coke fire should be lit in a suitable portable receptacle, which may be placed in the ash-pan. A portion of the fire-bars must be removed for this purpose, so that the fire can be kept far enough from the tubes to avoid overheating them. By leaving the manhole and mudhole doors off, the vapor formed in the boiler will escape.

If the boiler is to be laid up for a long period of time, quicklime in suitable trays should be placed in the upper and lower drums. The drums should then be closed up to exclude the air, care being taken to remove the lime before filling the boiler with water. The object of the quicklime is, of course, to absorb any moisture that might remain in the interior of the boiler and cause corrosion. Another reliable practice when laying a boiler up is, after it has been thoroughly washed out, to close up all manhole and mudhole doors and completely fill the boiler with fresh, clean water, adding 9 pounds of common washing soda to each ton of water, this soda being absorbed in the water before it is put into the boiler. Again, care should be taken before starting the boiler under these circumstances to thoroughly empty it. Other precautions to be taken when laying up the boiler are, to put the funnel covers on to prevent rain wetting the tubes and casings. If the boiler is to be laid up for a long time, it is also very desirable that the brickwork should be removed, and only replaced when required.

A bolted joint is provided to the lower water pockets of the smaller Yarrow boilers. The joint is made with asbestos metallic sheeting 1/16 inch thick. Before breaking this open the weight of the boiler should be carried on lugs provided for that purpose at each end of the lower tube plates. When remaking the joints of these water pockets, after having screwed the joints up as tightly as possible, steam should be raised to 10 pounds per square inch gage to thoroughly warm the boiler and then the bolts in the joints finally tightened up.

These joints should be broken only in case of important repairs.

When it is intended to raise steam, the boiler should be filled with water to the top of the gage glass and 1 or 2 pounds of ordinary lime per thousand gallons should be added in the form of milk of lime. Care must be taken that the lime is well mixed before being put in the boiler, and the lime water should be passed through a fine strainer.

When the boiler is in operation every opportunity should be taken to shut down each boiler in rotation in order to examine the brickwork and clean the tubes inside and out. The two or three rows of tubes nearest the fire require more careful attention than the others, and, if any accumulation of sediment is found, it should be removed before the boiler is started again.

PROPER METHODS OF FIRING.

In firing the boiler, a thin, even fire should be kept, taking care to keep the corners of the grate covered. There is far more risk of wasteful consumption of fuel by having too thick a fire than by having too thin a one. The thickness of the fire must, of course, be determined, to a great extent, by the kind of fuel used and the amount of forcing desired. On the average, a thickness of from 5 to 6 inches has been found to be suitable with Welsh coal. When charging the furnace the coal must be thrown on in the exact places where required, and not piled up at the front end of the grate and afterwards pushed back, as is customary with ordinary marine boilers. The ash-pit doors must always be kept shut and properly secured, so that in the event of a boiler tube bursting or steam suddenly escaping from any other cause, it may not find its way into the stokehole. For the same reason the fire doors should be kept closed, except when stoking. In the event of a serious leakage of steam, the fan should be immediately turned on to force the escaping steam up the funnel. The stokehole should be closed, the pumps turned on at full speed, and the fire extinguisher put into operation.

No oil should be allowed to get into the boiler. If any oil is used for the internal lubrication of the machinery, it should be mineral oil, although in many engines it is found that oil can be dispensed with altogether in the cylinders. As little oil as possible should be used for lubricating the piston rods, because a certain amount of this oil invariably finds its way into the cylinder, and thence to the boiler. Special care should be taken that the auxiliary engines should not be such as to involve the use of oil for internal lubrication. At all events an ample area of feed-filtering surface should be provided.

TREATMENT OF FEED WATER.

The water used in the boiler should always be distilled, and only when unavoidable should be obtained from the shore, as that will often lead to the formation of scale. Tests should be made frequently to ascertain whether there is any acid in the water or not. Not only should it be alkaline, but it must be definitely so. For this purpose from 1 to 2 pounds of ordinary line per 1,000 indicated horsepower should be pumped daily into the feed, as milk of lime, or even more, if found necessary, to insure the water being decidedly alkaline. Tests for the acidity of the water can easily be made with litmus paper. On no account whatever should sea water

be allowed to get into the boiler. This means that special pains must be taken to see that the condensers are tight; that the evaporator does not prime; and that all sea connections are properly shut. If, however, sea water does get into the boiler, double the ordinary quantity of lime should be used with the feed, the fires must not be forced and the density kept as low as possible.

HOW TO TREAT A SCOTCH BOILER IN ORDER TO OBTAIN THE BEST RESULTS.

BY C. A. M'ALLISTER, ENGINEER-IN-CHIEF, U. S. R. C. S.

In its general characteristics a Scotch boiler is not so totally unlike a horse, or other beast of burden, as might at first be imagined. We are taught from infancy that kindness and intelligent treatment of dumb animals will bring forth reciprocal good results from our four-footed friends. While it is not proposed in this brief article to carry out the analogy between the treatment of boilers and that of horses, it is hoped that some of the ideas set forth may indicate, metaphorically speaking, the proffering of lumps of sugar to our steel shelled producers of horsepower.

In these days an ill-designed boiler of the Scotch type is the exception, rather than the rule, as might be said of boilers built some twenty or thirty years ago. This happy state of affairs has been brought about largely by an interchange of ideas and experiences through the media of boiler makers' societies, good text-books, and articles appearing from time to time in technical papers devoted to engineering subjects. While we of to-day may ridicule the products of the pioneer boiler designers, yet, on sober, second thought we must credit to their mistakes (oftentimes costly in money as well as in human life) our present knowledge, which enables us to avoid the shoals upon which they foundered. We will therefore assume that we are to handle a modern Scotch boiler in which the ratio of heating to grate surface, the size of combustion chambers, the area through the tubes, the spacing of the tubes, the proportioning of water spaces and the hundred and one other details of boiler designing have been carefully thought out, not so much from the scientific standpoint as from the data gained by the rough experiences of our predecessors.

If asked to name the most important rule as a maxim to be adopted by the man in charge of a marine boiler of the Scotch type, I would unhesitatingly say that it is "Avoid sudden changes of temperature." From the first starting of the fires until the boiler has been allowed to cool off after a long period under steam, this rule must be kept continuously in mind if the best results are to be obtained.

The necessarily thick shell plates of the modern Scotch boiler must be heated slowly in order to avoid leakage at the joints from the undue strains which accompany sudden changes of temperature. Consequently steam should never be allowed to form in a Scotch boiler under 6 hours' time from the lighting of fires, and if circumstances permit it is much better to take 8, or even 12, hours for this operation. As one of the inherent faults of all tank boilers is the large volume of "dead" water underneath the furnaces, too much stress cannot be laid upon the importance of artificially circulating the water in the boiler, either by use of the hydrokineter or other circulating devices, or by the well known and always available method (where at least one boiler is under steam) of connecting up the auxiliary feed pump to draw from the bottom blow connection and discharge through the feed-check valves. This provides a uniform heating of the boiler shell throughout, and the consequent avoidance of trouble engendered by having a volume of cold water under the furnaces while steam is being raised.

When steam is formed, the careful engineer will see that all air is expelled from the boiler before closing the air cock and the safety valve. He should also, in every instance, see that the cock in the pipe leading to the steam gage is open. This may appear to be a trifling detail, yet we must remember that only within the past three or four years a boiler explosion on an American vessel, which caused the loss of nearly two scores of lives, was directly traceable to the neglect of this very function, unimportant as it may seem.

After steam has formed, the pressure should be allowed to rise very slowly; the longer time taken the better for the boiler. After the pressure has reached the desired point, the boiler can be "cut in," and here, again, great caution must be exercised; never open the stop valves suddenly. It is always preferable to open the auxiliary stop first, and that should be just cracked from its seat until the pressures are equalized.

So much has been said and written about correct methods of firing that it is practically impossibde to bring forth any new ideas on the subject, yet it may be well to reiterate some of the generally approved maxims. Quickness in firing is most desirable, in order to minimize the time when the cold air of the fireroom is drawn in over the fires and comes in contact with the highly heated plates of the furnaces and combustion chambers. To insure this a sufficient quantity of coal should always be laid out on the floor plates immediately in front of each furnace, so that the fireman will not have to take a few steps away to reach the coal when charging the furnace, which is often the case when the coal passer has loafed on the job and dumped the coal haphazardly around the fire room. Systematic firing is undoubtedly the best, that is, each furnace should be charged in regular rotation, care being taken that no two furnace doors are opened at the same time. The same rotation should be adopted in slicing the fires. Ashes should never be allowed to accumulate in the ash-pans, as this is only a form of laziness, which results in the refuse from the grates becoming banked up so as to interfere with the draft.

The great tendency of all firemen is to get at the fires which are to be cleaned when they first come on watch, so as to get a bad job over with. Frequently it will be the case that several of them will be cleaned at one time, with the result that the steam will drop, the revolutions naturally falling off, and the speed of the ship for the first hour of a watch show a marked decrease. This should be avoided by never allowing more than one fire to be cleaned at a time; the whole number to be cleaned should be distributed uniformly throughout the 4 hours. There will then be no irregular fluctuations in the pressure, with the consequent variations of temperature; incidentally the temper of the engineer of the watch, who is striving to keep up the revolutions, will not become ruffled. All old-time firemen, and many new ones, delight in carrying "crown sheeters," as they term a furnace when it is simply stuffed with coal to its utmost capacity. This method, although it gives the fireman more time to smoke his pipe, violates all of the laws of God and man, so far as efficient combustion is concerned. Fires of a uniform thickness, from 8 to 12 inches, according to the circumstances, will be found to give the best results, and although they require a little more attention, the coal bills at the end of the month bear ample testimony of their efficiency.

When, as is bound to occur, the tubes become clogged and it is necessary to blow them out with steam, or even sweep them in extreme cases, the work should be performed with the greatest celerity. Never should more than one nest of tubes be swept or blown at a time, as nothing more deleterious can be imagined than to allow cold air to come in contact with the tube sheets for a prolonged time. Quick

and snappy must be the work of the men handling the lance or brush as the case may be. All fire-room crews are prone to pass this disagreeable duty up to the "next watch," but it is a matter that should be attended to promptly, as the bad effects of clogged tubes are very noticeable on the steam gage and revolution counter.

It may safely be said that nine-tenths of the economical running of marine machinery begins in the fire room. The engineer who only visits the stokehold occasionally to see if the water is being carried at the proper level is not doing his duty to the steamship owners. A systematic training of the stokers in the essentials above enumerated and a rigid supervision of the fire-room force at frequent intervals will necessarily result in such a saving of fuel as will well reward the efforts put forth.

It is a well-known hygienic fact that nearly all of the diseases to which humanity is subject arise from improper feeding. The same may be said of steam boilers. If nothing ever passed through the feed-check valves but absolutely pure, hot water, there would be few, if any, troubles, with the interior surfaces. A general recognition of this fact is resulting in minimizing boiler disorders. However, from causes too numerous to mention, it is seldom possible to keep up a continuous supply of water possessing those desirable qualities. The general discontinuance of the use of cylinder oil in the main engines has removed one of the principal causes of trouble, yet, even now, it is practically impossible to run certain auxiliaries without the use of some oil. Large tank capacity and evaporating plants have solved the problem of furnishing sufficient fresh water for boiler use, yet we still have to contend with leaky condenser tubes, poorly seated manifold valves, etc., which, in spite of all precautions, allow some salt water to get into the boilers. Then, too, even the fresh water obtainable at many of our sea ports contains sufficient deleterious ingredients which cause trouble from scale deposits, etc. It is, therefore, highly essential that the engineer exercise vigilance in the care of his Scotch boilers. Nothing is more important than a daily test of the water; with the high pressures carried nowadays the old-fashioned salinometer test is not sufficient to keep him informed as to the true state of the water.

The greatest care must be exercised to keep the water in a neutral or slightly alkaline condition. The most feasible method to determine its acidity or alkalinity is the well-known litmus paper test. For a few cents sufficient litmus paper may be obtained to last for a month. No scientific knowledge is necessary to make this test; all that is essential is to draw a glass of water from the boiler and dip therein a small strip of the blue paper. If the paper turns red, the water is acid, and steps should at once be taken to neutralize it by adding an alkaline solution. Nothing better has ever been found than plain sal soda, at a cost of about 1 cent per pound. Remember, always, that electrolytic action, galvanic action, or "eating away," whichever you may choose to call it, does not occur unless an acid medium exists.

As before stated, the old-fashioned salinometer does not give the engineer sufficiently accurate data as to the amount of solid matter in the boiler water to be of much use in caring for modern boilers. In the old days of "pump and blow," saturations of 2, 2½, or even 3, were quite common, but for present purposes a saturation of ½, or even ¼, should be looked after. With the ordinary hydrometer everyone who has had experience knows how futile it is to read such small graduations. It is therefore much better to provide in the boiler outfit a small bottle of nitrate of silver; by adding a few drops of this liquid to a glass of water drawn from the boiler the smallest amount of saline matter may be detected by the cloudiness produced in the water. If an undue amount is shown, it is quite evident that salt water is getting into the boiler, and if none but fresh water has been used for "make-up" feed, it must then be concluded that the condenser tubes are leaking, or some valve in the manifold needs regrinding.

The best method for keeping oil out of the boiler is to keep it out of the feed water. If lubrication must be used in the main engine cylinders and valve chests, do not use oil, but use graphite mixed with water or kerosene. This material cannot possibly harm the interior surfaces of the boiler; on the other hand, it is probably beneficial in tending to prevent corrosion. If some oil must be used in the dynamos, feed pumps, etc., then take great care to remove it from the feed water by careful filtering in the feed tank. It takes but very little oil on the crown sheets of Scotch boiler furnaces to cause sagging, and if you have several furnaces out of round, then you have a real cause for worry. The careful engineer should, whenever a boiler is being cleaned, tram its furnaces to see if there are any signs of sagging. A drop of ½ inch can hardly be determined by even the most trained eye, and if a furnace goes beyond that limit it is liable to sag in a hurry, and generally at the most inopportune time. While furnaces which have sagged as much as 2, or even 3 inches, may run along for a time, it is certainly anything but comforting to the engineer of the watch to know that they are in that condition. The old saying of "A stitch in time saves nine," is very applicable to sagged furnaces. If they are down, for instance, only 1 inch on one trip, the next trip they may come down with a rush, so it is better to have them "jacked up" at once.

The advisability of fitting zincs to Scotch or any other kind of marine boilers is now so generally recognized that there can be no argument against such usage. In cleaning a boiler, particular pains should be taken that all zincs should be renewed where they have disintegrated to such an extent as to be useless. If sufficient metal is left in the block to warrant further use, the surfaces of the zincs should be carefully chipped or scraped, in order to present bright metal for the galvanic action. There should also be good metallic contact between the slabs and the containing baskets, as well as between the handles of the baskets and the stays to which they are attached. If this is not attended to there will be as little chance for efficient working as there would be to get a good current from a galvanic battery with poor contact at the terminals.

To cure many of the evils incident to poor management of boilers, there has been as much quackery as there was in the early practices of alleged doctors on mankind. All sort of material, such as tan bark, horse manure, potatoes, etc., have been prescribed by boiler quacks to correct certain evils. It does not seem possible that even now some engineers can be found who believe in the efficiency of these so-called "old-fashioned remedies," yet the writer has had his attention called to an instance, which occurred within the last month, where the chief engineer of a tugboat dumped two bushels of potatoes through the manhole of the boiler of which he was in charge, on the supposition that they would remove scale. Probably better results would have been obtained by giving an extra allowance of this favorite vegetable to the firemen at mealtimes. It is not intended to convey the idea that all "boiler medicines" are fakes, as it is now very generally conceded that there are several boiler compounds on the market, prepared by reputable firms from the formulæ of expert chemists, which undoubtedly are of great benefit in preventing or removing scale and in minimizing electrolytic actions.

Much more might be written on the subject of good treatment of Scotch boilers than has been outlined in this brief review of the principal methods now employed, but it is hoped that, brief as have been the foregoing suggestions, they may attract the attention of some engineers so that there may

be even a slight improvement over the existing methods of treatment which may have been adopted for the boilers in their charge.

INSTRUCTIONS FOR THE WORKING AND MANAGEMENT OF DÜRR BOILERS.

SETTING TO WORK.

The boilers should always be filled with clean, fresh water up to slightly below the usual water level, because, when steam is raised, the bubbles of steam passing up through the water chamber cause the water level to rise considerably. Steam should be raised slowly when the boiler is heated for the first time, or when the brickwork is new; later on, steam can be raised in about 30 minutes, or as quickly as the fires can be got to work.

Care should always be taken to drain the superheater before connecting the boiler to the steam pipes; for not only is there a possibility of water being left standing in it when the boiler has been kept full, but also when the boiler has been shut off.

After the boiler has been working for a short time, the water chamber and the tube-hole doors should be carefully examined, as it is quite possible that at first some of the water-chamber doors may blow, or become leaky, as the working pressure increases. If such should be the case, the nut should be slightly loosened, and, after bringing the door into the correct position by light tapping against the cap, again screwed up.

MANAGEMENT OF THE FIRES.

The combustion should be maintained with as short a flame as possible, and should cease before the heated gases reach the tubes. There should consequently be an ample supply of air, and the fires must be kept thin. Under natural draft the thickness of the fires should be about 4 inches, and even under forced draft they should not, if possible, exceed 5 inches.

For a steady pressure of steam a uniform condition of the fires is indispensable, for the production of steam in boilers with small water chambers depends almost entirely upon the rate of combustion. The most advantageous method would consequently be a continuous, uniform feeding of the furnaces; in order to approach this desideratum as nearly as possible the fires must be fed uniformly with small quantities of coal, and at short intervals. A practical standard is a charge of 2 pounds per square foot of grate area. As the grate area behind each furnace door is usually from 10 to 13 square feet, the charge per door should consequently be from 20 to 26 pounds of coal.

If a boiler has several furnace doors, greater uniformity of stoking will be insured if the doors are served at alternate intervals. For boilers which have a number of separate furnaces each with two doors, open the first door of each furnace at regular intervals, and open the second door at the next intervals. If several boilers are in the same stokehold, the furnace doors should be numbered in such fashion so that alternately one after the other one-half of the doors shall always be served.

It often happens on board ship, whether in consequence of unequal draft in the stokehold or in the funnel, that one boiler, or one fire of a boiler, has a more powerful draft than the others, and that the fire consequently burns away more quickly; in such case the combustion should be regulated as far as practicable by means of the ash-pit, or uptake dampers. Under forced draft, however, the ash-pit doors are always to be kept fully open; the fire with the greater draft should consequently receive temporarily a larger charge, so as to keep it up to the same thickness as the others. The coal must be thrown on quickly, and the furnace doors should not be kept open a moment longer than is necessary to stoke the fires, so as to prevent too much cold air getting into the furnaces. On opening the furnace door, the stoker should see the whole grate at a glance, and decide what parts require the coal, for the smoke caused by the first shovelfull, as soon as it is thrown in, prevents the condition of the fire from being seen. The coal at the sides of the furnace burns away more quickly, in consequence of the glowing heat of the brickwork, than that in the middle; therefore the fire near the brickwork should be kept rather thicker.

CLEANING THE FIRES.

Cleaning the fires should be carried out in the same way as stoking them; viz.: with the furnace doors in series, so as to minimize any fall in the pressure of steam. If necessary, while one fire is being cleaned, the others may be slightly more heavily forced. If a fire, or a half a fire (*i. e.*, that portion of a grate lying behind a furnace door) requires cleaning, it should be worked through a few times with the rake at the usual intervals for stoking, until it becomes thin, and not till then should the cleaning begin; the work will then be easy, because the fire is thin.

The ash-pits are made watertight, and should always be kept full of water, so as to cool the ashes which fall through the bars.

CLEANING THE FIRE SURFACE OF THE TUBES.

With good coal, and when steaming under natural draft, this cleaning requires to be done every five or six days at the most. The dirt principally accumulates on the baffle plates and on the upper sides of the tubes, *i. e.*, especially where dead angles in the current of the hot gases occur. When forced draft is being used, the tubes can be cleaned in a very simple manner as follows: The boiler room with closed furnace and ash-pit doors is placed under as high an air pressure as possible, while the fan is allowed to run for some time at full speed; then first one furnace door and then the other is opened, followed alternately by the covers of the lattice wall, the strong draft thus blowing both the soot and flying ash into the chimney. It is advisable to shake the plates while blowing.

When forced draft is not being used, the cleaning is done by a steam jet. The lance is pushed in lengthways between the tubes, either through hollow stay-bolts in the water chamber from the stokehold or from behind through cleaning holes in the lattice wall covers.

Cleaning by means of steam jets should only be done while the boiler has its fires lighted and working; it should never be done with banked fires. The cleaning should be commenced from the top, because only the lighter soot passes off through the funnel, while the heavy dirt drops down below. If a very large amount of dirt should have accumulated on the baffles, it must be drawn out from behind through the lattice wall.

In course of time deposits of ashes and clinkers begin to form on the lower sides of the bottom rows of tubes, the clinkers having been carried by the forced draft from the furnaces, and driven against the tubes, to which they occasionally stick and get burnt on. These deposits must be scraped off from the furnace.

WATER LEVEL.

Generally speaking, the Dürr boilers are constructed of such water capacity, and with so large a water surface, that a check valve in the feed pipes of each boiler, placed at a convenient height, is quite sufficient to enable the water level to be kept at the right height. It must not be forgotten, however, that the water level rises and falls with the steam production of the boiler, as a result of the larger or smaller

number of steam bubbles present in the water chamber. If, therefore, for any reason, the water level has fallen very low, and the pumps are worked quickly, the steam production, by reason of the introduction of the cold feed water, will be somewhat diminished, and, as a result, a sinking in the water level will again be brought about. The feed should consequently be regulated a little before the normal level is reached, or otherwise the water will stand too high when the development of steam again becomes normal.

Hot feed water increases the regularity of the steam production and the efficiency of the boiler, consequently efforts should be made to heat the feed water as much as possible before putting it into the boiler.

SCALE AND FOULING.

The addition of salt water to the feed has a tendency to make the boiler prime, and for this reason it must be avoided, quite apart from the deposits which it leaves in the boiler. It is necessary that the boiler water should be tested each watch. If any increase in the amount of salt present becomes apparent, and the defect cannot be discovered and remedied, care must be taken by blowing off that the amount in solution does not exceed 1 percent, or otherwise considerable precipitation will take place on the heating surfaces. With surface condensation, fouling of the feed water by the lubricants of the steam cylinders is unavoidable.

In order to neutralize the finely disintegrated fat in the feed water, and also to neutralize any acids, it is advisable to add a solution of soda or milk of lime to the feed. In using soda, however, great care must be exercised, for even a small excess of soda in the boiler water may cause the boiler to froth; not more, therefore, than 1 pound of soda should be used to 1 pound of cylinder oil.

The most effectual way, however, of preventing fouling of the boiler is to clean the feed water outside the boiler by filtering. The first essential for efficiency in the filter is that the feed water shall pass through slowly, *i. e.*, a large filtering surface is necessary.

ACTION TO BE TAKEN IF THE ENGINES ARE SUDDENLY STOPPED.

If the steam requirements are suddenly greatly diminished, or altogether stopped, the rate of combustion must also be diminished, otherwise the steam pressure will very quickly rise and the safety valves will blow. One of the first steps is to close the ash-pit doors, and if that is insufficient, to slightly open the furnace doors so as to allow cold air to enter the furnaces. Opening the furnace doors, however, must be done gradually to prevent any too sudden cooling of the heating surfaces—especially of the lower tubes; if this precaution be taken the boiler will not be injured, for the Dürr boiler, by reason of its construction, is not hurt by sudden changes of temperature. A further decrease in the production of steam can be brought about by increasing the feed; indeed, this to a certain extent will occur quite automatically; but the boilers must not be allowed to get too full.

SHUTTING OFF THE BOILER.

If the boiler is to be shut off, the first thing is to blow through all surface blow-off and sediment cocks until all accumulations of dirt have been removed, the boiler is then pumped up again to the usual level unless it needs emptying to carry out any repairs. If the boiler is to be out of use for some time, it should be pumped full for preservation. Meantime the fire is allowed slowly to burn down, so that the circulation in the boiler may be kept up as long as possible, which will prevent the dirt still remaining in the water from settling in the lower tubes.

After the fires have been drawn the grates and brickwork of the furnaces should be thoroughly cleaned from slag, then the ashes should be drawn and the water drawn off from the ash-pan; after that the furnace and ash-pit doors and the chimney dampers should be closed, and the boiler be allowed to cool down slowly. After the boiler is cool the superheater should be drained, otherwise water may remain standing in the tubes, and so cause them quickly to rust.

REGULAR INSPECTION.

Whenever a boiler is put out of use an external inspection of the lowest rows of tubes and of the brickwork in the furnace should be made.

In the Dürr boiler the tubes are only jointed to the boiler body at the front end, while the back ends lie free, and with a certain amount of play, in the lattice wall. The tubes can thus not only expand freely lengthways, but are enabled also to compensate to a certain extent for inequalities of temperature. In the lowest rows of tubes, which are exposed to the direct action of the fire, and to the radiation of the whole of the furnace, the amount of bending when the boiler is forced is so great that the top of the tubes press tightly against the lattice wall. The counter pressure on the back ends of the tubes thus exerts a frequently recurring tendency to bend, which in time brings about a permanent upward bend of the tube; the tubes when cold then lie bent (under tension) in the lattice wall. A gradual curvature of the lower tubes is, therefore, quite naturally brought about, and need give no cause for anxiety in the Dürr boiler.

On the other hand, if a sudden considerable curvature is observed to take place in the lower tubes, this is almost always a sign of extensive internal fouling. Under such circumstances immediate cleaning of the interior of the tubes is necessary.

Defective places in the brickwork should be repaired as soon as possible, and special care should always be taken that the protective arches over the furnace doors are kept in good condition.

Periodical examinations should be made to ascertain the extent of internal fouling of the boiler, because on board ships the method of working and the quality of the feed water are never so uniform that definite periods can be laid down for cleaning.

The water in the chamber is run off, and the hand-hole doors of a few tubes in the lowest row are opened; the inner tube is withdrawn, and the water standing in the outer tube is run out either with a syphon from the front or by opening the tube doors from the back of the boiler. The outer tube is then carefully inspected all along with a light, and some of the deposit is scraped off; if no deposit is found in the tubes of the bottom row one may be pretty certain that the whole of the tube nests are also free, and there is no need to continue the examination; on the other hand, if any deposit is found, it should be ascertained how far the dirt extends by taking out other tubes in different parts of the boiler. Care should always be taken to examine the bottom side tubes, because sediment easily collects there in consequence of the lesser amount of evaporation and the more sluggish circulation.

INTERNAL CLEANING.

If the deposits in the tubes have attained a thickness of 1/32 to 1/16 inch the boiler should be cleaned; if, in addition, any oil refuse (leavings) should be found in the boiler, the boiler should be boiled out with soda. To do this 1 pound of soda for every 10 feet of heating surface is put into the boiler, which is then filled up to the customary level and heated with slow fires for some 12 hours, allowing the steam, at a pressure of from 40 to 50 pounds, to blow off through the safety valves; after boiling for a few hours water should be blown out through the scum-cocks, and also from time to time through the lower blow-out valves, taking care to constantly feed up with fresh water. After the boiling out is finished the fires are drawn, and the water chambers are blown out empty through the outboard blow-off pipe. Before the boiler gets

quite cold the water chamber hand-holes should be opened, the inner tubes drawn out, and the outer tubes should be washed, with the warm water still in them, with a round steel wire brush; then open suddenly the back doors of the tubes, each tube is at once emptied, the powerful stream of water carrying with it all the dirt which has been scraped off.

If after this cleaning there should still remain any scale in the tubes, it must be removed by scraping. The scale so scraped off is washed out by a stream of water.

Accumulations of pieces of scale will be found at the bottom of the back halves of the headers, which, after the cleaning of the tubes has been completed, should be withdrawn through the mud holes or through the lower hand-holes. On the other hand, mud and oil refuse will be found in the front halves of the headers, which can be cleaned off with turpentine or be brushed out and washed away after boiling out the boiler.

Fatty deposits on the inner tubes are most easily removed by burning off, the tubes being held for a short time in the furnace of a boiler at work. If, however, the deposits are of a more earthy nature, the inner tubes, as soon as they are taken out of a boiler, provided the mud is not yet dry, should be lightly cleaned by springing and washing off.

Part of the dirt which floats on the surface of the boiler water will remain sticking to the walls of the steam collector, where in time it will form a thick crust, which must be scraped off every time the boiler is cleaned. With rapid evaporation, and especially if any priming should occur, small portions of this dirt may be projected even beyond the steam pipe and lodged in the corners of the separator. These recesses should therefore always be watched and kept clean so as to prevent any narrowing of the sectional area. Any fouling of the superheater will only be observed under the rarest circumstances; it is therefore sufficient to carefully empty it, dry it and to slightly grease both the outer and inner tubes with cylinder oil in order to protect them from rusting.

If the layer of scale in the tubes should by any chance attain such a thickness and hardness as to be no longer removable by scraping, which may possibly happen after steaming with river water holding mud or scale in solution and making use of condensation by injection, then the tubes must be taken out for thorough cleaning.

CLEANING THE FIRE SURFACES.

After continuous working, especially with slow combustion, a tarry residue, distilled from the coal, attaches itself to the tubes and becomes more or less burnt on. This can only be removed by sweeping with very hard brushes and by scrapers after the boiler has stopped working. Cleaning should commence with the upper tubes. The tubes should first of all be swept with brushes to sweep down the loose ash from them and from the baffles; then the more tenacious crust must be scratched off with the double scraper.

The lower tubes should be cleaned, especially on their lower sides, which are exposed to the fire, and should have the slag sticking on to them scraped off; then the tubes should be carefully examined for bends and any signs of wear. The brickwork must be without cracks and fit well everywhere. Finally, the soundness of the whole lagging should be examined, and any loose places should be repaired. Special care should be taken that the back protecting doors fit well into their framings, and that the asbestos packing is in good condition; for any access of cold air to the boiler above the furnaces is accompanied by a loss of draft and efficiency.

REMOVAL AND REPLACEMENT OF HANDHOLE DOORS AND END DOORS OF TUBES.

If a header door has to be opened, after taking the nut and cap off the bolt, a special driver is placed over the bolt, and by lightly tapping it (the driver) the door is loosened and driven inwards. Before fastening up again, the bedding surface of both doors and holes should be well cleaned, and may rough places made smooth. Emery powder is only to be used when absolutely necessary, and then only very fine grained. Before replacing the doors in the holes the bedding surfaces should be lightly smeared with graphite paste; the thread on the bolts of the doors should also be lubricated with graphite before screwing on the nuts, which will considerably facilitate their subsequent removal. The doors must only be screwed up with the usual length spanner which accompanies the boiler.

In opening the tubes at the back the work must be done carefully, so as to avoid loosening the tubes in the cone seating. After the nut and cap have been removed, the door opener is placed over the bolt, the trigger fitting over the tube end where it fits in the circular collar and the door forced into the tube by turning the pressure screw. Opening by hammer blows on the door opener is strictly forbidden, because the tube might be driven out of the cone of the header wall. Long rods, which seize the doors by means of springs, are used to pull out and push in the doors from the front end of the tube.

For tubes which have outer fastening, cap, nuts, etc., it is necessary that the back tube end should be held firm. The lattice wall-cover is taken off, and a tube holder is placed over the end of the tube which fastens it on to the lattice wall. Before putting together again, all bearing surfaces and threads must be well cleaned and smeared over with graphite, so as to prevent them getting rusty.

REMOVAL AND REPLACEMENT OF TUBES.

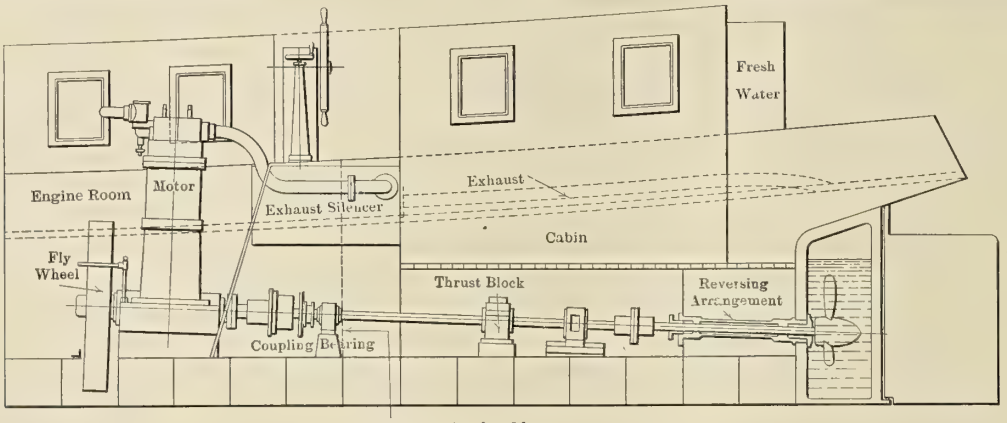
If, on examining the boiler, it is found that any tubes, possibly in the lower rows, are too much bent—bends up to ½ inch are of no consequence—the tubes should be taken out and straightened. If a tube, however, shows any signs of swelling, which is an infallible sign of dangerous overheating of the metal, it must be changed. In order to pull out the tubes, after the inner tube and the back end door have been removed, rods are inserted in the tubes from the front, which seize the back tube end with disc trigger and wedge, and are drawn in front of the chamber with pulley and nut catch-hook. By gently tapping with a hammer against the back end of the rod, the loosening of the tube in the cone is facilitated. Driving out the tubes only by blows on the back end without the special withdrawing apparatus must be strictly prohibited, because adjacent tubes may thereby become loose in the cones.

In replacing the tubes, care must be taken to prevent any foreign matter getting in between the bearing surfaces. The tubes can be forced in either with a screw press or by hydraulic pressure. Hydraulic pressure is to be preferred, as one thereby has a greater control over the amount of pressure exercised. While being forced in, light blows should be given with a wood hammer so as to overcome the passive friction, and to bed the tube properly in the cone. New tubes are pressed into the tube holes some ¼ to 5/16 inch if the tubes have been previously bedded by light blows on a wooden plug in the cone. Tubes which have already been forced in no longer enter to such an extent with the same pressure, but only some ⅛ to 3/16 inch. With each fresh forcing in, the tube cone sets somewhat deeper in the tube hole until finally the safety collar prevents any further entry. So long, however, as the seating available for forcing in is as much as ⅛ inch, one may confidently depend upon the tube being tight, even if the safety collar touches the header wall.

If it appears when the tube is put in position that the requisite ⅛ inch of bearing surface for properly fastening the tube is not available, the tube must be taken out again and the cone expanded. The expanding of the tube cones is done by tube rollers of the ordinary construction after putting over the joint a heavy steel gage ring bored to the size of the standard cone.

PRESERVATION OF THE BOILER.

Good preservation of the boiler can only be obtained with the boiler quite full—wet preservation—or, with the boiler quite empty—dry preservation. When it is probable that the boiler will not remain long idle and an internal cleaning is not needed, the wet preservation commends itself for choice. If the boiler is to remain unused for some time, then the dry method of preservation is preferable.



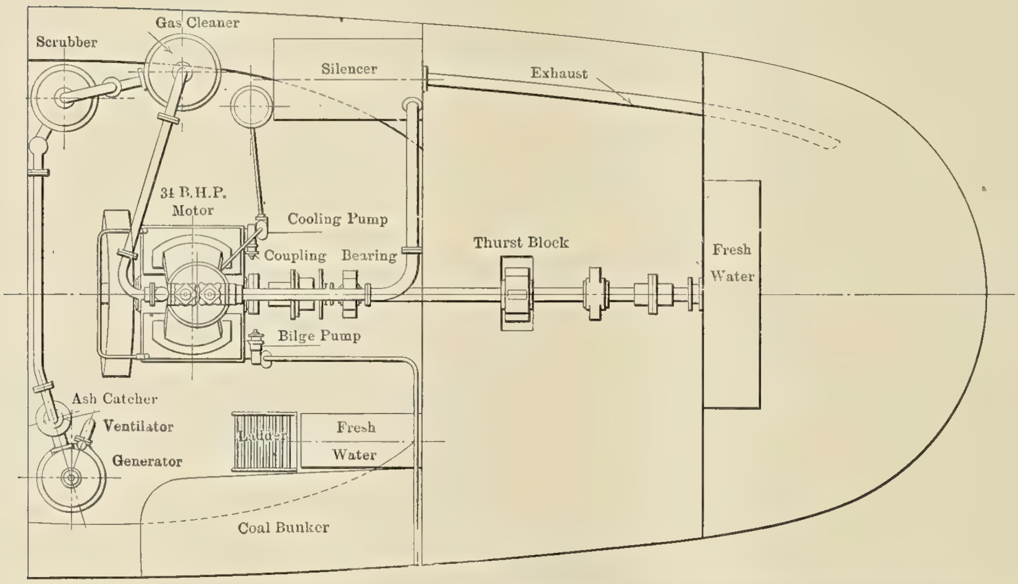


FIG. 1.—ENGINE-ROOM ARRANGEMENT FOR A 16-BRAKE-HORSEPOWER MARINE PRODUCER GAS PLANT.

DUTCH MARINE SUCTION-GAS PLANTS.—II.

BY F. MULLER VAN BRAKEL.

Suction-gas boats always have a separate engine room. Even in *Marenging,* where the installation is of the simplest, producer and motor are placed in a separate compartment. Oil engines can be placed under a casing, so a bulkhead may be dispensed with in very small boats, but suction-gas plants need space for the following items: First, bunker, producer and the firing; second, scrubber, water vessel, gas cleaner and exhaust silencer, and third, water filter, fresh-water tank, board with oil cans, etc. All this makes an engine room indispensable.

In the vessels described in this article the engine room is always placed aft. The room above the propeller tube is in the larger vessels (50 tons and upwards) taken by the cabin; in the smaller ones by the cockpit. When there is a cabin the pilot house is situated just forward of it, above the after part of the engine room; otherwise, the steering wheel or tiller is on the after deck or in the cockpit. (See Fig. 1, showing the arrangement for a 16 brake-horsepower and Fig. 2 for a 34 brake-horsepower installation.) This location of the engine room is natural. It gives short connections between the parts for coupling and reversing and the corresponding handles at the steering wheel; short shafting and an easy control of the engine room by the skipper at the wheel. It has the disadvantage, however, of making the ship liable to load by the head. As there is ample breadth in this part of the ship the engine room may be rather short, 9 feet being sufficient for installations up to 24 brake-horsepower and 10 feet for those up to 34 brake-horsepower.

The arrangement of the principal parts of the installation usually indicates the route taken by the coal and the gas. That is to say, from the aft corner port side to the forward corner port side is the bunker, next comes the producer with ash catcher; then through an overhead tube the gas is led to the scrubber in the forward starboard corner and to the last gas cleaner. From here through another overhead tube the gas passes to the motor, and then to the exhaust silencer in the aft corner starboard side.

It will be seen that the length of the engine room is fixed by, first, the length of the motor; second, the room forward of it necessary for passing, and, third, the necessary space aft for couplings, etc. An oil engine would take at least the same length of engine room, and so it may be said that in freight boats of ample beam a producer installation does not require any more room than an oil engine.

The weights for a gas and for an oil installation of 24 brake-horsepower, and for a 34 and a 115 brake-horsepower gas installation, are as follows:

TABLE I.

	24 B. H. P. Oil.	24 B. H. P. Gas.	34 B. H. P. Gas.	115 B. H. P. Gas.
Motor complete, cwts	46	55	59	225
Producer, ash catcher, scrubber, gas cleaner, water vessel; and for 115 B. H. P. motor: Small spiritas-starting motor	..	25	30	172
Engine seatings, coupling and reversing parts, silencer, sea valves, piping, hand pump, etc	see motor weights	20	21	57
Thrust block and shaft, propeller shaft and tube, propeller	see motor weights	20	22	24
Complete installation, cwts	46	120	132	478
Lubricating oil, etc	4	4	4	8
Fuel for 100 hours	19	15	20	85
Complete installation and fuel	69	139	156	651
Complete steam installation and fuel for 115 B. H. P.	..	...	...	895

So the oil motor has about half the weight of the producer installation without fresh water. That means a difference of about 3½ tons, which is equal to 2.35 percent of the cargo weight in a 150-ton ship, or 3.5 percent in a 100-ton ship. It should be remembered, however, that the shipbuilder considers this extra weight near the stern a very good thing, as these ships with engine room aft have a tendency to load by the head.

ECONOMY.

A calculation of the yearly cost of running a producer-gas boat, an oil-motor driven ship and a steamship will show the advantages of one or the other type. Some of the amounts, such as those for repairs, depreciation, insurance, etc., are open to discussion. The amounts for coal and oil consumption are, however, exact, being taken from actual experience.

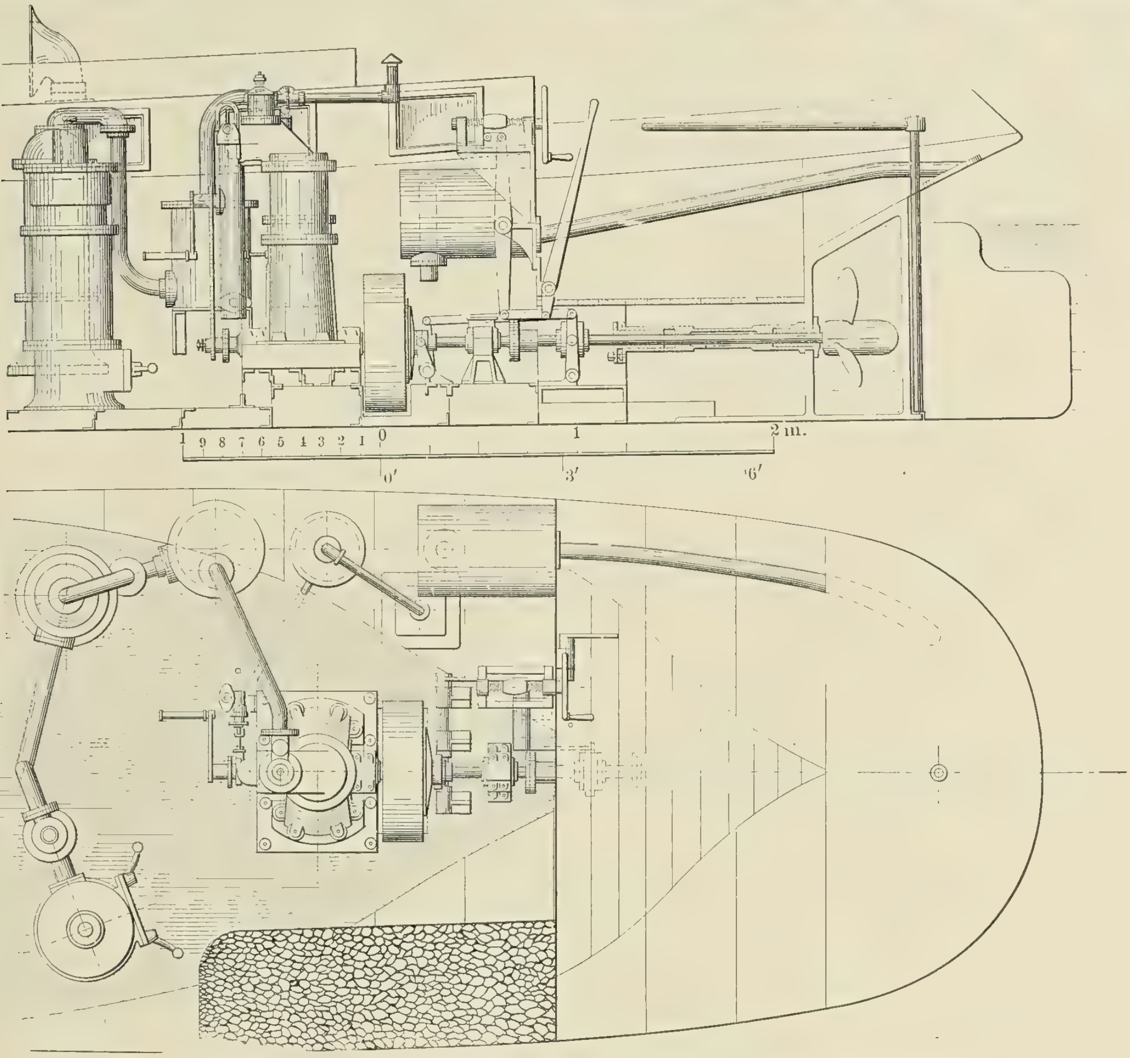


FIG. 2.—ENGINE-ROOM ARRANGEMENT FOR A 34-BRAKE-HORSEPOWER MARINE PRODUCER GAS PLANT.

As it makes a great difference whether the ship is in service many or only a few hours every day, the calculation is made for three different cases. The first is for 1,100 sailing hours per year, the actual time of a 120-ton freight boat with a 31 brake-horsepower gas motor, which has been in regular service between Rotterdam and the north part of the Netherlands since 1904. Next, the time is taken as 1,800 hours per year, corresponding to 300 days of six hours each. And, lastly, the calculation is made for the somewhat exceptional case of 3,000 hours per year, to show where the advantage of gas over steam begins to tell.

For low powers the comparison is made with a 31 brake-horsepower Kromhout oil motor, built by D. Goedkoop, Jr., Amsterdam. The market price is $1,470 (£302). It consumes 0.82 pound of oil per brake-horsepower, costing $1.40 (5/10).

For high powers the gas plant is compared to a steam installation, consisting of a vertical, compound, surface condensing engine, 10 inches by 20 inches by 13 inches, and a marine boiler of 645 square feet heating surface, producing steam at 155 pounds per square inch. Total cost of engine and boiler is $4,600 (£945), and the coal consumption 2.65 pounds per brake-horsepower, costing $0.48 (2/0).

The 31 brake-horsepower gas installation is an existing plant fitted by Messrs E. J. Smit & Son in the above-named 120-ton ship, 81 feet by 15 feet 3 inches by 5 feet 3 inches. The cost of the installation is $2,600 (£534). It consumes 1.1 pounds anthracite per brake-horsepower-hour, costing $0.32. The cost of the boat is $4,600 (£945).

The 115 brake-horsepower gas plant has been fitted by Messrs. E. J. Smit & Son in two 260-ton boats, 117 feet by 21 feet 6 inches, which cost $8,400 (£1,725). This gas installation costs $6,400 (£1,314), and consumes 0.85 pound of anthracite, costing $0.245 (1/0½) per brake-horsepower-hour.

TABLE II.

Ship 81′ x 15′ 3″ x 5′ 3″. Price $4,600.

Depreciation 5 percent	$230
Rent 5 percent	230
Repairs ½ percent	23
Insurance 2½ percent	115
	$598

TABLE III.

31 H. P. Gas Plant, Price $2,400. Oil Motor, Price $1,470.

	1,100 Hours Gas.	1,100 Hours Oil.	1,800 Hours Gas.	1,800 Hours Oil.
Depreciation— For gas, 1,100 hours 9½ percent. 1,800 hours 10½ percent For oil, 1,100 hours, 7 percent; 1,800 hours, 8 percent	$228	$103	$251	$118
Rent 5 percent	120	74	120	74
Repairs 1 percent "	24	15	24	15
Insurance 2½ percent	60	37	60	37
Lubricating, cleaning, etc	50	30	80	45
	$482	$259	$535	$289
Fuel— Gas, 31 x 0.32 x 1-100 x hours Oil, 31 x 1.4 x 1-100 x hours	$110	$477	$178	$780

TABLE IV.

	1,100 Hours.		1,800 Hours.	
	Gas.	Oil.	Gas.	Oil.
Ship	$598	$598	$598	$598
Engine plant	482	259	535	289
Fuel	110	477	178	780
Total	$1,190	$1,334	$1,311	$1,667

Thus for 1,100 hours' sailing per year gas is about 13 percent cheaper, and for 1,800 hours about 28 percent cheaper.

TABLE V.

Ship 117′ x 21′ 6″ x 7′ 10″. Price $8,400.

Depreciation 5 percent	$420
Rent 5 percent	420
Repairs ½ percent	42
Insurance 2½ percent	210
	$1,092

The high amounts for the depreciation of gas engines may, perhaps, seem unnecessary. It should be remembered, however, that the gas leaves a deposit in the cylinder that does *not* lubricate, as in the case of oil, or even steam engines. Though forced lubrication is used for the pistons, these still wear considerably, usually leak soon, and have to be renewed after some four or five years. Moreover, the deposit settles on the valve settings in the form of very small solid grains, which become very hard and make the valves leak. The frequent grinding wears the valves and settings seriously, and, when a hard grain gets between the valve and setting, pieces of the valve are occasionally broken off.

TABLE VI.

115 B. H. P. Gas Plant, $6,400. 115 B. H. P. Steam Plant $4,600.

	Gas	Steam
Depreciation— Gas 10 percent, steam 8½ percent. (mean values)	$640	$390
Rent 5 percent	320	230
Repairs, gas 2 percent; steam 1 percent	128	46
Insurance 2½ percent	160	115
Lubricating, cleaning, etc	85	55
Engineer	300	300
	$1,633	$1,136

Fuel.	1,100 Hours Gas.	1,100 Hours Steam.	1,800 Hours.	3,000 Hours.
Gas, 115 x 0.245 x hours	$310	...	$505	$840
Steam, 115 x 0.48 x hours	...	$610	990	1,660

TABLE VII.

	1,100 Hours.		1,800 Hours.		3,000 Hours.	
	Gas.	Steam.	Gas.	Steam.	Gas.	Steam.
Ship	$1,092	$1,092	$1,092	$1,092	$1,092	$1,092
Engine plant	1,633	1,136	1,633	1,136	1,633	1,136
Fuel	310	610	505	990	840	1,660
	$3,035	$2,838	$3,230	$3,218	$3,565	$3,888

The calculations show that for low powers gas is cheaper than oil, by amounts varying from 13 to 30 percent. But for higher powers, where steam would be used in the place of oil, steam is generally cheaper than gas. It should be remembered that the steam plant needs an engine room length of 30 feet against 18 feet 9 inches for the gas installation, which makes a difference of 780 cubic feet of cargo space in favor of gas. The steam plant weighs about 45 tons, against 32½ tons for the gas installation, giving 12½ tons more cargo for the gas-driven boat.

CONCLUSION.

The question may now be asked, when is it advisable to fit a marine producer-gas plant in the place of an oil or steam plant?

The present stage of development of the marine producer plant, so far as it has been carried in Holland, at once limits its use to powers under 100 brake-horsepower, as plants for higher power are at the present time too costly to compete against steam. If the demand for producer installations increases they will undoubtedly become cheaper, and, perhaps, become a serious rival for steam plants. As things stand now, however, it seems that the crude-oil motor promises better for the future than the gas motor. In Holland alone two modifications of the Diesel motor are being constructed with special regard to marine use.

For speed and pleasure launches producer plants are not as desirable as oil motors, because of their greater weight (of first importance in speed vessels), the greater space they occupy and the delay in starting caused by the firing. Moreover, as producer installations are only thought of where economy is desired there would be little inducement to adopt them here.

There remain commercial boats of low power, say 15 to 75 brake-horsepower. The above calculations show that in this case the producer gives a decided advantage over oil engines.

This advantage, however, is only reached when—

1. The skipper is a good, trustworthy man, who takes pains to understand the installation and keeps it in very good condition.

2. The ship makes enough sailing hours every year to make the fuel-saving advantage perceptible.

3. The fuel prices are not too high.

4. The right sort of anthracite is obtainable in the port from which the vessel sails.

From point (2) it follows that a gas plant cannot be recommended as an auxiliary in sailing vessels.

THE MARINE STEAM ENGINE INDICATOR—IV.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

PAPER DRUMS.

The accuracy of the indicator depends, to some extent, on the design of the paper drum and its mountings. Lightness is almost as important here as in the pencil actuating mechanism, and for the same reasons, *i. e.,* the effects of inertia. Where plain drums are fitted they are practically the same in all instruments, the principal differences being in the springs for turning the drums against the pull of the cord and the methods used for changing the spring tension. The drum consists of a hollow metal cylinder, fitted with fingers or clips for holding the card, the whole mounted on a base which revolves about a shaft secured to the body of the instrument. The axis of the shaft is parallel to the bore of the steam cylinder. In some cases the rotating springs are made of flat steel, mounted spirally after the manner of a clock spring; in other designs the springs are helical and made of round wire, encircling the shaft. Certain advantages are claimed for both forms by the various makers. The arrangement of the drum will be easily understood on inspection of the pictures of assembled instruments which will be shown hereafter.

DETENT MOTIONS.

In order that the paper "cards" may be changed on the drums without unhooking the cord, the drums are usually, but not always, fitted with a detent motion. This, in the majority of instruments, consists of a combination of ratchet teeth on the periphery of the drum base-ring, and a pawl on the indicator frame. When the pawl is thrown in the drum is caught and held stationary at the limit of its rotation against the pull of the spring. This fundamental idea is varied slightly in different instruments.

In an instrument made by the American Steam Gauge & Valve Manufacturing Company the paper drum is disengaged from its base-ring by the movement of a lever. The drum stops while the base continues its motion. The drum and base are again thrown into gear by a simple movement. With this mechanism five diagrams have been taken by a skillful operator in a little over one minute.

Many indicator manufacturers are now putting on the market instruments furnished with drums for taking continuous cards. These cards take a strip of paper from 6 to 12 feet long. The paper is fed along automatically or otherwise, so that it is possible to take from 75 to 150 diagrams on the strip. This arrangement, of course, adds something to the weight of the drum, but is exceedingly useful and almost a necessity where exhaustive tests are to be made of engines working under rapidly varying loads. Continuous diagrams, taken from a throttling rolling mill engine by a Schaeffer & Budenberg instrument, are shown in Fig. 32.

FIG. 32.

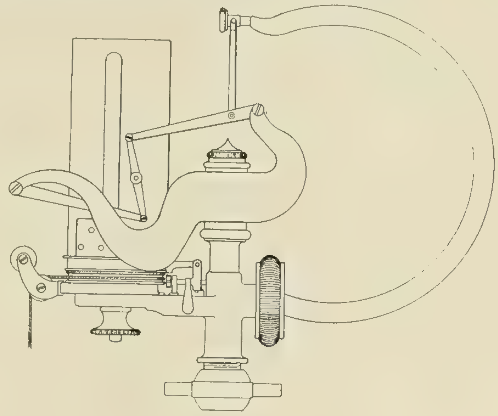


FIG. 33.

ELECTRICAL ATTACHMENTS.

To get reliable data from multiple-cylinder engines working under varying loads, such as in the case of a ship in a heavy sea, it is necessary that all indicator diagrams be taken simultaneously. In order that this may be accomplished by one operator, electro-magnets, or solenoids with suitable gear, are so fitted that the swivel heads of all the instruments are rotated by pressing a button. This brings all the pencils in contact at the same time. If indicators are attached to each end of each cylinder, a complete record can be made in a little over one revolution of the crank shaft. Devices operated by compressed air have also been made.

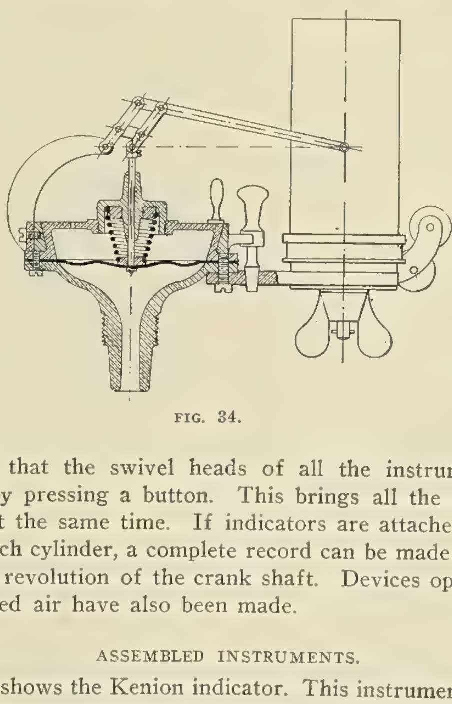


FIG. 34.

ASSEMBLED INSTRUMENTS.

Fig. 33 shows the Kenion indicator. This instrument is fitted with a peculiar spring and has no piston. The spring is similar to that of a steam gage tube, the partial circle formed by the spring expanding and contracting with the varying pressure. This movement is transmitted to and multiplied by the pencil motion, as shown in the sketch. It will be observed that the pencil mechanism is of the Watt or Richards type.

Fig. 34 is the indicator of Hädike. In this case the instru-

ment is fitted with a flexible diaphragm in lieu of a piston. The parallel motion is a good illustration of the pantograph, as applied to the indicator pencil.

Fig. 35 illustrates one form of the Rosenkranz instrument. The parallel motion of this instrument is designed with a non-

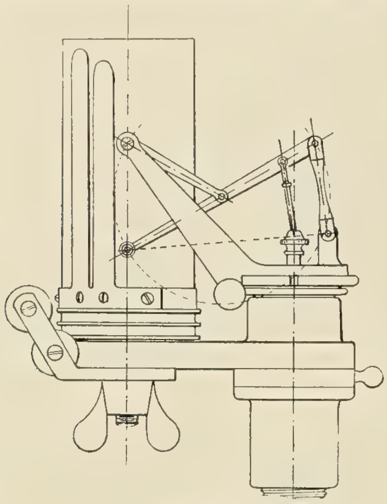


FIG. 35.

shortened front link, and with a back link so located that the versed sine of its arc of travel will be inclined. The action of a mechanism of this kind has already been discussed at some length and will be seen diagrammatically in Fig. 26.

(*To be continued.*)

NOTES ON THE OPERATION OF BABCOCK & WILCOX BOILERS.

In the design of the Babcock & Wilcox boiler seven prominent features are embodied: Straight tubes, expanded joints, forged steel, large furnace volume, adequate and practicable baffling, ability to clean exterior surfaces, accesibility to entire interior surfaces.

To the operating engineer the last two features are perhaps of the greatest importance, for cleanliness, more than any other one thing, is conducive to good steaming capacity, the saving of fuel and to prolonging the life of the boiler.

The baffling of the Babcock & Wilcox boiler directs the hot gases of combustion three times across the tubes before they escape to the up-take, thus insuring thorough distribution over the heating surface and consequent low final temperatures of the waste gases. Each of the three "passes" thus formed is provided with a series of dusting doors in the side casing, closed by patented air-tight shutters, giving access to the space between each pair of tubes. A steam lance, therefore, inserted successively through these openings effectually removes the soot from the exterior surface of the tubes. When performing the operation of blowing tubes always have full steam pressure on the lance, and move same in and out and from side to side to make the steam jet cover all the surface. Also have the boiler in operation if possible, the damper open and a good draft to take the soot away. If closed fire-room is installed, have a strong air pressure on. Place the lance first in the dust-door nearest the furnace, *i. e.*, the bottom opening in the "first pass," and "follow the gases" through the boiler, finishing at the opening nearest the up-take, *i. e.*, the top hole in the "third pass."

Nobody can lay down a fixed rule as to how often it is necessary to "blow tubes." The tubes are *accessible* for cleaning, however, and when the boiler is steaming and flame passing across the tubes, the dust and soot can be easily seen by inspection through the dust-doors. The old rule, "an ounce of prevention is worth a pound of cure," is a good one to follow, and it should be the object of the man in charge to utilize the ample means provided and keep *the boiler clean.*

The same remarks as to frequency of cleaning apply to the inside as well as to the outside of the tubes. Hand-holes are provided opposite each end of each tube. These are of the familiar elliptical type known to our forefathers, or a modification thereof. The plates are made of forged steel, and are faced to receive a thin gasket, as are also the seats on the inside surface of the forged steel headers against which the plates fit snugly. When making joints, use a seamless gasket made of asbestos, with wire insertion. A gasket cut from a strip and brought round and "pieced," will surely give trouble in the end, and could not even be considered "cheap at half the money." Do not soak gaskets in oil, as this rots them, but use plumbago on one side—the side next to the header. For convenience mix the plumbago with a little water. Wipe and clean the faced seats on the header and on the hand-hole plate carefully.

Owing to the fact that the tube is straight, the entire interior surface becomes visible to the observer on the removal of a hand-hole plate at each end. The frequency of cleaning depends on the condition of the water, amount of make-up feed and capacity at which the boiler is operated. A periodic examination is the only proper method to pursue.

The most satisfactory method of cleaning the interior surface of the tubes is to employ a turbine cleaner propelled by water power. A pressure of about 125 pounds per square inch is best, and fresh water is preferable, although salt water may be used in emergency, provided special care is exercised to wash out with fresh water and drain thoroughly afterward. When the scale is soft and light, hand scrapers may be used effectively.

The straight tubes and the location of the hand-hole plates provide the same facility for repairs as for internal cleaning; and the use of the expanded joint, familiar through long usage in shell boilers, greatly simplifies the question of repairs, which in nearly all instances may be made by the operating force without calling on the boiler maker. The same time-honored methods of cutting out tubes and nipples and re-rolling joints apply to the Babcock & Wilcox boilers as to shell boilers.

Should it be necessary to replace a tube, the new tube may be purchased in the open market, cut to length and without bending or threading or other work being performed on it, quickly installed in place by the use of the common expander. The tube should lap about ½ inch over the inside of the header seat. While it is a simple matter to plug a tube in cases of necessity, it takes so small an amount of extra time to replace a defective tube with a new one that this latter course is usually followed, and it may be noted that this sort of repair work makes the boiler as good as new—not patched.

Internal corrosion becomes a more and more acute malady as the steam pressure carried becomes higher, for the reason that with the consequent higher temperature of the contained water, the magnesium chloride, which is contained in all sea water, and which, unfortunately, too frequently gets into the feed system, becomes more and more corrosive. It is a matter of prime importance, therefore, to keep the condensers tight and to "freshen" up the boiler water by blowing down and adding good, fresh, make-up feed. A thin egg-shell scale, formed by feeding lime water to a new boiler, is a desirable thing, and a partial protection against corrosion; but do not be led astray by the idea of making a "salt scale"; it will not work at high pressures.

Another very corrosive element attacking the interior surface is air in the feed water; and while the internal feed arrangement adopted in Babcock & Wilcox boilers does very much to separate the air from the incoming feed, it is advisable to raise the filter box to insure a submerged suction to the

feed pump and give the air a chance to escape, and also to install air chambers on the feed line, acting as reservoirs in which the air may be collected and held until discharged.

The well-known tests for salt and acidity should, of course, be applied to the boiler water, and an effort made to keep same fresh and neutral (or slightly alkaline) and free from air. If this is done and the zincs are kept clean and in substantial condition, the bugbear of corrosion may be reduced to a minimum.

The operating engineer who knows his business well enough to keep his boiler clean *inside and out* and free from corrosive influences is in a fair way to finding himself in charge of a model steam plant and needs little other advice. Possibly, however, a few words about water tending and firing may not be out of place. The Babcock & Wilcox boiler, of the design common in the merchant marine, contains about four times as much water as the express type of boiler of equal size, and is in consequence not subject to the rapid fluctuations in water level that characterize the latter; tending water being therefore a much simpler process. The aim should be to alter the checks *a little at a time,* thus maintaining a uniform feed, and it will be found that a very steady water line results. On the contrary, if the checks are opened wide one minute and closed tight the next, the water tender will soon be blaming everything but his own stupidity.

As to the matter of firing little need be said. The large combustion space of the Babcock & Wilcox boiler makes good results possible with very indifferent firing, providing the grates are covered, as the gases in passing back under the reverberatory roof have ample opportunity to mix and burn completely before getting in among the tubes of the boiler proper. Good firing will, of course, give proportionately good results, and a valuable rule is, "Light, Even and Often." The large, high furnace does offer one temptation to the firemen which should be guarded against: they are liable to want to pile it in and make a coal mine instead of a fire.

The level grate, with all fire-doors at the same firing height, is conducive to ease in handling the fires, and the main object of the fireman should be to keep the furnace *hot.* If the boiler is clean, it will absorb the heat effectually and make steam economically, and plenty of it. If the boiler is dirty, the reverse will be the case, and the object of this article will not have been fulfilled.

NOTES ON THE INGLIS BOILER.

The Inglis boiler is a modification of the ordinary Scotch boiler. It has three or four furnaces, as in the ordinary cylindrical type. It is fired in the same way, and as regards stoking and attention there is no difference between it and the ordinary type of boiler. The difference begins, however, immediately behind the furnace bridges. Instead of the gases passing from the fire grate direct through the tubes, the gases from the three furnaces all meet in one common combustion chamber of special construction at the back of the furnace bridges. The combined gases then pass through a second combustion chamber, in the form of a corrugated flue, to a third combustion chamber at the front of the boiler, where they enter the tubes, which extend from front to back end plates. This plan ensures that the cold or green gases from any one furnace, while being fired, get thoroughly mixed and ignited by meeting the hot gases from the other two furnaces, while the gases at the same time pass an extra or third time through the boiler. It further ensures that the gases, when they reach the tubes at the front of the boiler, are constantly of a uniform temperature, thus obviating entirely the principal cause of leaky tube ends; and since the tube plate is at the front of the boiler the formation of scoria thereon when forcing becomes an impossibility.

The third or front combustion chamber is formed by a removable brick-lined chamber, which further helps to maintain an equal temperature at the tube ends. Where heavy forcing and rapid steam raising are required, instead of a brick-lined chamber a water-jacketed cover is used, which acts as a circulator, the water-jacket being fed entirely from the very bottom of the boiler, and discharged into the steam space, the circulation also being assisted by four vertical watertubes in the back combustion chamber.

Another important difference in design is that the tubes are carried the whole length of the boiler. Of course, the tubes are longer than in the ordinary type, and, as a consequence of this, the heating surface is increased in the direction most capable of transmitting the heat to the water. Due to its greater facilities for circulation and to the more uniform temperature throughout the boiler, steam can be raised from cold water to a pressure of 180 pounds in eighty minutes without in any way damaging the boiler.

Aside from the fact that the boiler will stand a great deal more forcing in a closed stoke-hold without damage, the same principles that apply to the care and management of a Scotch boiler should be observed with the Inglis boiler.

HANDLING OF THE TAYLOR WATERTUBE BOILER.

The Taylor watertube boiler is a sectional boiler, having twenty-eight sections. Each section consists of thirty-three interchangeable elements, giving the boiler 924 short, vertical tubes for circulation and steam generation. The elements are joined at their ends by internal right and left nipples of forged steel, the ends thus forming headers. The construction is such that any element can be removed and replaced in two hours' time.

When placed in the boiler the upper and lower headers of each section all but touch the corresponding headers of the adjoining sections, thus forming what corresponds to a crown sheet above the fire, and closing the top of the flue passage. Near the back end a space is left in which there are no sections, the water-legs at the sides running to the height of the upper headers. This forms an efficient combustion chamber exactly similar in form to the combustion chamber of the Scotch marine boiler.

The fire burns back through the furnace, passes up into the combustion chamber, and then takes a horizontal path to the front of the boiler, coming in contact with the 924 tubes on its way. After passing through the nest of sections the heat rises through the up-take in front and then passes through the nest of feed-heating coils to the stack. The fact that the volatile gases have to pass back over the fire and then enter the combustion chamber is indicative of good combustion; and the long travel of the hot gases through the restricted flue area, with the ample amount of heating surface presented to them, meets the requirements of good heat absorption.

In firing the boiler no previous experience with pipe boilers is necessary, as the furnace, being in its nature practically the same as that of the Scotch boiler, is fired exactly as the Scotch would be. The green coal is fed into the front of the fire and later pushed back. This compels the gas to pass back over the glowing fire, and insures the best combustion. The two or three furnaces, as the case may be, should be fired alternately, as the combustion chamber is common to all of the furnaces, and the incandescent gases from the glowing fire will help complete the combustion of the gases from the freshly-fired one. Steam pockets, and the burning consequent from them are claimed impossible.

The arrangement for handling the feed water in the Taylor boiler has been carefully worked out, with the idea that the best way to keep a boiler clean is to prevent any scale-forming matter from entering it. If the boiler is blown out according to the directions it will be impossible for scale to get into the tubes. The feed water after passing through the coils is fed into an impurity separator to remove any mud or other matter held in suspension. This consists of a 5-inch pipe with the ends capped and the lower part encased in the brick work around the fire front. The feed passes into the separator from the top, and is carried straight down to about its middle by an internal pipe. The feed water and the impurities are projected downward with a velocity nine times as great as is the flow of the water up in the separator to the outlet at the top. The sediment will therefore settle in the bottom of the separator, where it is protected from the heat, and where the water is therefore quiet. From the top of the separator the water is piped to the drum, and enters the drum at about the water-line, or is sprayed into the steam space. It then reaches a very high temperature, and any scale-forming matter held in solution is precipitated.

As the down-flows tap the drum several inches above the bottom, the sediment traps in the drum, and is removed by opening the blow-off, which is piped to the bottom of the drum. Should any be carried down the down-flow pipes it will settle in the mud-drums, and will be removed by the bottom blows, as there is but little circulation through the mud-drums or up the water-legs. It will be seen that the blow-off valves from the separator and from the drum are the most important, and they should be used as often as experience shows to be necessary. At intervals, depending on the use, the boiler should be given a thorough blowing out, which may be done by first blowing all the water from the drum through the drum-blow, and then blow down from the bottom blows until the water is several inches below the top headers. It will be seen that until the drum is empty there will be practically no circulation down the water-legs from the sections, for until it is so the water would come down the down-flows from the drum. The engineer should watch the discharge from the blowing at first, and should set his intervals and the amount blown by the amount of dirt that he sees discharged. Where steamers are on a daily run, about once in two weeks the boiler should be fed a solution of salsoda an hour or so before the end of the last trip, and this allowed to stand in the boiler all night. In the morning it should be drained off and the boiler rinsed out and then refilled.

Steam lances are supplied with the boiler, which blow five ways at the end, and with these the flue space can be kept perfectly clean, both fore and aft and between the tubes.

Any engineer who will give the boiler ordinarily good care can get the most excellent results from it, for it has a big, square section of furnace with an even height above the entire grate; the fire burns back to the combustion chamber, giving the very best possible combustion; the travel of the heat is through a long and properly proportioned path, with no chance of short cutting and with abundant heating surface surrounding it; the steam leaves the heating surface and rises immediately to the steam space, leaving the heating surface at all times covered with water and preserving its heat-absorbing capacity, and the rapid circulation increases the heat-absorbing capacity of the tube surface.

According to the *Engineering Record*, suction gas tugboats have been tried on the Rhine, towing cargoes of 350 tons in two barges. The boats are said to have proved successful and reliable, the cost of fuel being from 50 to 70 percent less than that of steam tugs. Lignite, mined in the neighboring provinces at very small cost, is used for fuel.

INSTRUCTIONS FOR OPERATING ALMY BOILERS.

The care that should be given an Almy boiler differs little from that required by boilers of any other type. It is hardly necessary to say that grease, salt and mud must be kept out of the boiler, and the heating surface free from soot and ashes, if repairs are to be obviated and the greatest efficiency obtained.

There is no reasonable excuse for allowing a boiler to suffer from grease. In these days of high pressure, the larger percentage of engines are fitted with piston valves which require little or no oil. Auxiliaries, especially pumps, need some cylinder lubrication, but if purely mineral oil or lubricant, or at least that which contains absolutely no animal fats, are used, a carefully looked after filter box will guard the boiler from any harm. With slide-valve engines more than ordinary care should be used in selecting cylinder lubricant to avoid animal grease,

As this boiler contains only about 10 percent as much water as a Scotch boiler of the same power, more care should be exercised and frequent blowing off resorted to if it becomes necessary to use salt water, as the density increases much faster than with the "tank" boiler. A condition that brings trouble to the engineer and repair bills to the owner is often brought about by a small amount (almost imperceptible) of salt, combined with animal grease, gradually but constantly fed into the boiler.

In order to obtain the best results freeing the boiler from sediment through the blow-off pipe, blowing should be done in the morning as soon as there is pressure enough to operate the blow-off, say 5 to 10 pounds. If the boiler has been laying quiet during the night, most of the foreign matter will have settled, and the blowing at this time will accomplish more than fifty times as much as when the boiler is in full operation.

There are many occasions when from scale or other internal troubles it becomes necessary to "doctor" a boiler, but it is far from wise to dose it with compounds of unknown ingredients, especially without knowing the origin or component parts of the scale.

The accessibility and ease with which repairs can be made to this boiler are worthy of more than a passing glance. As the sections are connected at either end with a union and asbestos gasket, it is an easy matter to remove a defective section and install a new one. Any of the side sections may be disconnected and taken out through the ash-pit doors. The fore-and-aft sections have to be taken out at the back of the boiler, unless the side sections on one side of the fire-box are removed, allowing the fore-and-aft sections to come out through the ash-pit door. It is not advisable to go to the trouble to replace one fore-and-aft section; better stop it off with an ⅛-inch metal disc in the top and bottom union, and leave it in place. The vertical pipes will, of course, burn away after a while, but it takes some time. After a number have been thus treated it is well to lay off and replace them all at once.

To remove and replace a section, first remove five or six grate-bars; next start the bottom union nut with a round-nose calking tool, and hammer and back it off. Let a man enter the boiler above the sections through the back door, and unscrew the top union nut in the same manner as the bottom one. Now pull the bottom end of the section into the furnace, and the section may be dropped into the ash-pit.

Clean off the face of the flanged nipples and put the new section in place; spring down the top (if necessary) and insert the gasket (asbestos about one-sixteenth inch thick should be used, not rubber); force the section up against the packing; screw on the union nut, using an 18-inch Stillson wrench or small chain tongs, and drive up solid with a round-

nose calking tool and hammer. Now do the same with the bottom end. Be sure to have the section end against the packing when screwing the nut on, else the nut may catch the packing and harm it. To haul a fire, blow down, stop off a section or remove and replace a side section and get steam again occupies from one and one-quarter to two hours' time.

Now a word about firing. You "Scotch boiler fellows" must forget all about Scotch boilers and become fearful that too much coal at a time will put the fires out, for it is about the same thing with the watertube boiler, so the firing must be done light and often. Try to keep a fairly level fire, with the sides and ends rather higher than the middle and the corners well filled up. There is a great opportunity to lose steam with lean corners. Do not let all the firemen fire at once. One shovel in a fire room is an excellent precaution. With soft coal, break up the fire with a hook. If you use the bar, do not turn the fire over, just lift it. If you have rolling bars, roll them often and leave them on a new square each time, and they will keep straight much longer. If you show a flame at the top of the stack "crack" your furnace doors. This will some times stop it even with very gasey coal.

Do not try to keep steam down by closing the damper when lying still, but open it and the cleaning doors in front, and let the air draw through; cooling down this way will not cause leaks in this boiler. Do not "pull your engine wide open" with a green or poor fire. If you do you will pull the water over, There is very little storage for energy in this boiler and you must depend on the fire for it. If you can anticipate your leaving time a few minutes, have your fires bright, take care of your surplus steam with the "bleeder," then when you get "full speed ahead" close your fire doors and "bleeder" and the boiler will respond.

Keep the heating surface clean, and you will save both labor and fuel. Be sure to have the steam jet in the stack in full operation while blowing off tubes, and the accumulation will all be taken out through the stack.

Now a few words about laying up. The time spent in thoroughly cleaning the heating surface for a six months' lay up should not be questioned by the owner, even though a man puts in six or seven days on a boiler, as ashes and soot collect moisture, and that is more or less corrosive in nature, which will deteriorate the metal much faster than actually operating the boiler.

After blowing off it is a good idea to thoroughly dry out the boiler with a light fire of wood. Then the heating surface should be scraped and dusted as completely as possible from top to bottom. All iron in ash-pans should be painted with iron oxide or red lead paint. Even painting the heating surface as far as possible is good policy. This or spraying with crude oil is desirable if no heat is to be kept in the fire-room during the winter.

SPECIAL POINTS TO BE OBSERVED IN THE UP-KEEP OF NICLAUSSE BOILERS.

One of the most important features of the Niclausse boiler is the arrangement of tubes. A form of joint is used which enables the tube to be taken down and replaced from the front of the boiler. The outside generating tube, which is put in first, fits into the back and front of the header by means of two long cone joints. The whole is held in position by means of a dog, which bears upon the center portion of the lugs of two adjacent tubes. The external tube is slightly thickened at the end where it joins the lantern, and is turned to a slight taper, fitting into a tapered hole in the rear plate of the header. The middle portion of the lantern, which is cylindrical and of slightly larger diameter, fits into the dividing plate or diaphragm of the header, and the extreme end, which is of larger diameter still, is coned, and fits a coned hole in the front plate of the header. The inner tube is also provided with a lantern of somewhat different form. The bearing points are at the diaphragm of the header and the outer portion of external lantern. The entire arrangement of tubes can, therefore, be taken out from the front of the boiler.

In general, Niclausse boilers afford good facilities for inspection and up-keep. It is not sufficient merely to empty the tubes from the front ends. They must be taken out and completely emptied unless the whole boiler, when laid up, is completely filled with fresh water and lime. Frequent inspections are necessary, as is the case in any boiler, to see that no deposits are occurring to stop the circulation. The taking down and replacing of the tubes must be done with care, so as not to injure the fine threads. The brick work in front of the boilers must also be carefully maintained.

Stoking with this type of boiler is, of course, very important, and must be regular and methodical. The same considerations apply here, however, as apply to stoking in any similar type of watertube boiler. There is one difficulty which should be guarded against very carefully, and that is any obstructions occurring between the inner and outer tubes which would tend to stop the circulation and cause overheating with possible rupture.

A special form of tube cleaner enables the tubes to be thoroughly cleaned without taking down the side doors. This can be done at little trouble, and therefore is likely to be done frequently, thus maintaining the efficiency of the heating surface. Cleaning is effected by fitting a hollow sleeve in place of a lantern here and there over the front of the boiler, through which the steam cleaning lance can be passed. It also enables the lance to be made of fairly large diameter, permitting a sufficient quantity of steam to blow through, not only to clean the tubes, but also to leave their surfaces practically dry. The use of the sleeve means the suppression of a few tubes and a consequent slight reduction in the quantity of heating surface, but compensation for this is found in greater cleanliness and consequent efficiency of the heating surface.

REGARDING THE OPERATION OF SEABURY WATER-TUBE BOILERS.

The Seabury watertube boiler comes in the class of small tube boilers with expanded tubes. It consists of a steam drum and two water drums, each water drum being connected to the steam drum by a series of seamless drawn-steel tubes, bent in such a way as to allow for their expansion. The steam drum is large, providing a large surface of water to evaporate from, an essential feature in the generation of dry steam, especially when forced under 5 inches of water pressure, thus burning coal up to 100 pounds per square foot of grate surface with a corresponding high evaporation. Many Seabury boilers for yacht and torpedo boat work, where forcing is carried to the limit, are built with steam domes, from which the dry pipe is always able to draw dry steam.

Over the top of the nest of tubes is a heater, consisting of steel pipes running lengthwise of the boiler, connected at the ends with return bends, making a continuous path for the feed water which enters at one end and passes through the whole length of the heater, then entering the drum through a check valve. No baffle of brick or any other foreign material is used, the baffling being accomplished by the arrangement of the tubes.

Wrought iron grate-bars of square section extend through the boiler front for the purpose of shaking. By means of this shaking grate a hard-coal fire can be kept clean and in good condition for a long period. A hard-coal fire cannot be sliced and worked the same as when soft coal is used, without ruin-

ing the fire; the shaking grate therefore offers the simplest and most effective method for marine work.

Cleaning doors in both ends of the casing, in way of nests of tubes, give access for cleaning accumulations of dirt from tubes and heater by means of a steam jet.

The main requirements for efficient working are: to keep the tubes and heater clean by frequent application of the steam jet, to keep the interior of the boiler free from oil by blowing down frequently, and by use of the surface blow, and, finally, to have the firemen trained to carry the proper kind of fire. It is also important that the water should not be carried much higher than the center of the drum.

The Seabury boiler is so simple that there are but few points about its handling which would be of help to the average engineer, other than the knowledge necessary to run any watertube boiler. Common to all watertube boilers of the small-tube variety, steam may be raised as quickly as a fire can be got on the grates. The water should be carried at about half a glass, at which level the upper row of tubes is submerged. Care should be taken to prevent the formation of steam in the heater. This is easily done by keeping the feed pump running (even though water is high enough in the glass) until the water is seen to rise perceptibly. This insures the heater being full of water all the time, and prevents the formation of steam in a portion of it, thus driving the water out into the drum and keeping up a false level in the glass. In short, never stop the pump except on a rising glass. Boilers should be kept clean, both internally and externally, by the frequent use of bottom and surface blows, and by the use of steam hose through the cleaning doors provided. The firing has to be varied to suit the kind of fuel and forced or natural draft, conditions understood by the average fireman, and not in any way peculiar to Seabury boilers. In laying up, it is always important to get all the water out; to do this the feed check between heater and drum should have its valve removed, and then after the bonnet has been replaced all the water in drum and heater can be blown overboard.

Annual Meeting of Naval Architects' Society.

The seventeenth general meeting of the Society of Naval Architects and Marine Engineers will be held in Assembly Room No. 1, Engineering Societies building, Thursday and Friday, Nov. 18 and 19, 1909, and will begin at 10 A. M. each day. The society's rooms will be open for the use of all members and the usual conveniences provided.

There will be a banquet at Delmonico's at 7.00 P. M., Friday, Nov. 19, to which all members and their guests are cordially invited; tickets are $5.00 each.

The Council will meet at 3.00 P. M., Wednesday, Nov. 17. Proposals for membership should be mailed so as to reach the secretary on or before Nov. 17.

The advance programme of the meetings is as follows:

THURSDAY, NOV. 18.

1. The Influence of Length of Parallel Middle Body upon Resistance. By Naval Constructor D. W. Taylor, U. S. N., vice-president.
2. The Influence of the Position of the 'Midship Section on the Resistance of Some Types of Vessels. By Prof. H. C. Sadler, member of Council.
3. Some Plane Ship-Shaped Stream Forms. By Assistant Naval Constructor William McEntee, U. S. N., member.
4. A System of Propulsion for Naval Vessels. By W. L. R. Emmet.
5. The Producer-Gas Boat *Marenging.* By H. L. Aldrich, member of Council.
6. Building and Equipping the Non-Magnetic Auxiliary Yacht *Carnegie,* with Producer-Gas Propelling Equipment. By Wallace Downey, associate member.
7. The Design of Submarines. By Marley F. Hay, member.

FRIDAY, NOV. 19.

8. The Foreign Trade Merchant Marine of the United States. Can it be Revived? By George W. Dickie, member of Council.
9. Material Handling Arrangements for Vessels on the Great Lakes.
10. Proposed New Rules for the Construction and Classification of Steel Vessels. By James Donald, member.
11. Rivets in Tension. By Robert Curr, member.
12. The Strength of Watertight Bulkheads. By Prof. Wm. Hovgaard, member.
13. Cruising Motor Boats.

THE FASTEST VESSELS IN THE UNITED STATES NAVY.

What have proved to be the two fastest vessels in the United States navy have just been completed by the Bath Iron Works, Ltd., Bath, Me. They are the *Flusser* and *Reid,* two of the five destroyers, bids for which were opened in September, 1907, and contracts for which were awarded as follows: The *Flusser* and *Reid* to the Bath Iron Works; the *Smith* and *Lamson* to the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., and the *Preston* to the New York Shipbuilding Company, Camden, N. J. The contract for the *Flusser* and *Reid* specified that the vessels were to be delivered to the commandant of the navy yard, Boston, Mass., not later than September 28, 1909.

The hulls of the *Flusser* and *Reid,* designed by the Bureau of Construction and Repair, are of the following dimensions:

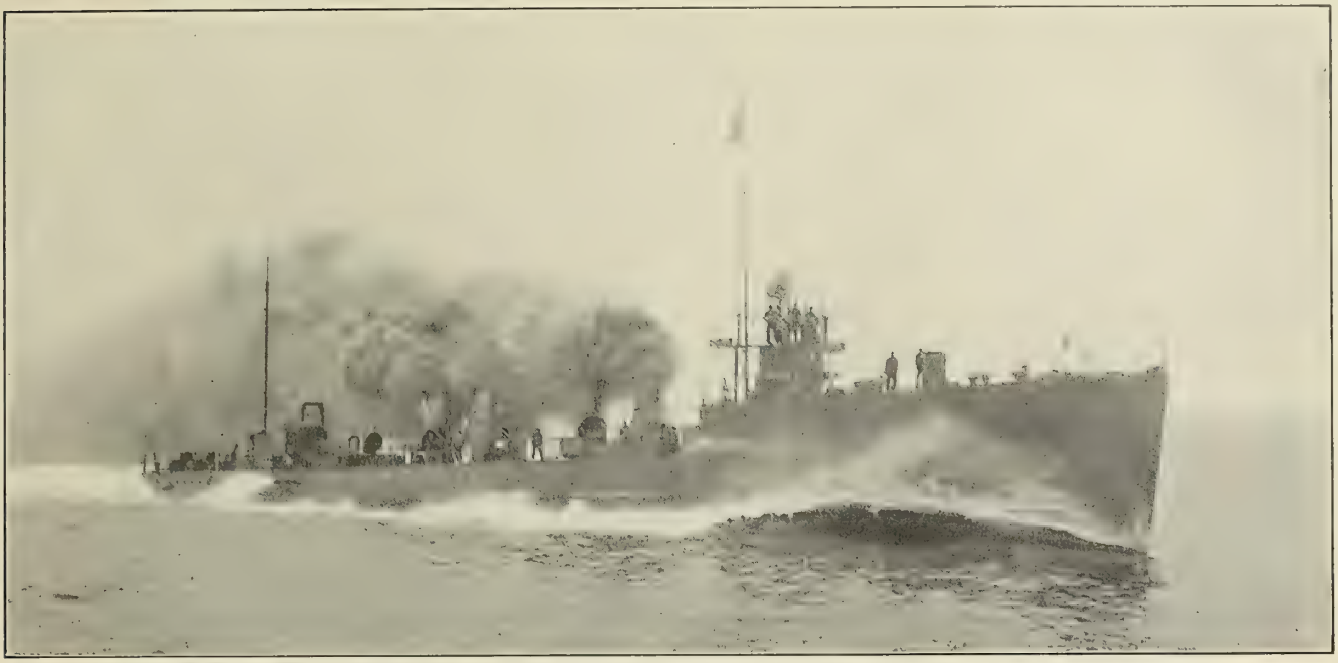
Length between perpendiculars	289 ft.
Length over all	293 ft. 10½ ins.
Breadth molded at trial waterline	25 ft. 11¼ ins.
Breadth molded extreme	26 ft. 4½ ins.
Breadth extreme over guards	27 ft.
Trial displacement	700 tons
Trial draft at this displacement	8½ ft.

As will be seen by the above dimensions the lines are very fine.

The contract weight allowed for the machinery was 255 tons, provision being made for the assessment of a penalty in case this weight was exceeded. The machinery, however, complete, with water and spares carried on board, weighed only 228 tons, so that the trial displacement was reduced by this saving of 27 tons, less an overweight of 4 tons, or a net weight saved of 23 tons. The trial displacement therefore was fixed at 677 tons, but on all of the trials of these vessels the displacement was slightly greater than this.

The machinery is of the contractor's design, and consists of five Parsons marine steam turbines on three shafts; the main high-pressure being on the center shaft; the starboard low-pressure and intermediate-pressure cruising turbines, together with the starboard backing turbine being on the starboard shaft, and the port low-pressure and backing turbine and the high-pressure cruising turbine on the port shaft. The steam piping is so arranged that any of these turbines can be run as the initial turbine. All of the turbines are in one compartment, and they were designed to develop 10,000 shaft-horsepower, at 800 revolutions per minute, with about 240 pounds of steam in the high-pressure steam chest.

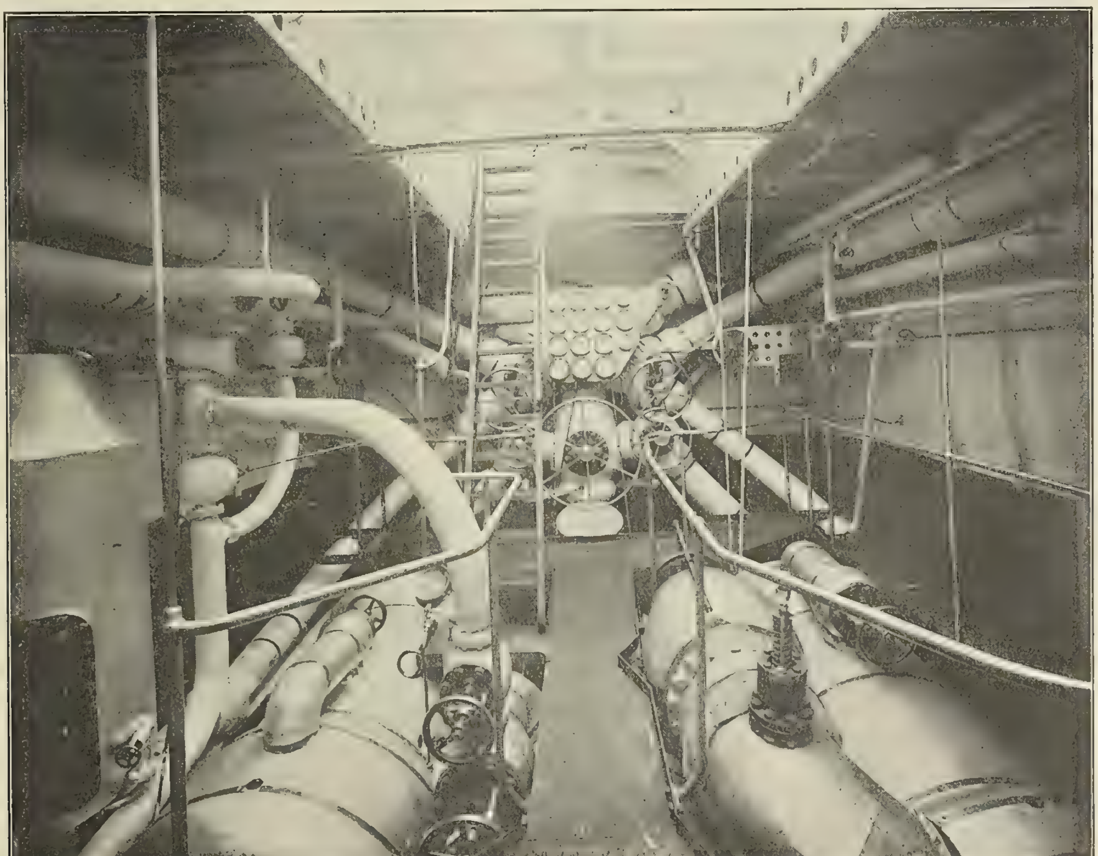
The two condensers were built up of plate with composition tube sheets, each containing 4,000 square feet of cooling sur-



THE NEW UNITED STATES DESTROYER FLUSSER STEAMING AT 33.7 KNOTS.

face, measured on the outside of the tubes. The tubes are curved and expanded into the tube sheets, no packing being used. The circulating water is provided by scoops, this method proving extremely satisfactory. Small circulating pumps, however, are provided for use when the vessel is still in the water, or when getting under way. There are the usual air pumps, feed pumps, fire and bilge pumps, oil pumps, etc. An evaporating distilling apparatus was also provided, with the necessary pumps.

The boilers are four in number, of the Normand return-flame type, and are placed in two water-tight compartments, there being a smoke-pipe for each of the four boilers. The total grate surface is 346.67 square feet, and the total heating surface 16,177 square feet. Normand feed-water heaters are



INTERIOR OF ENGINE ROOM LOOKING FORWARD. STARBOARD I. P. AND PORT H. P. TURBINES IN FOREGROUND.

also provided for each fire-room, and these have proved very efficient. Ash ejectors were also fitted.

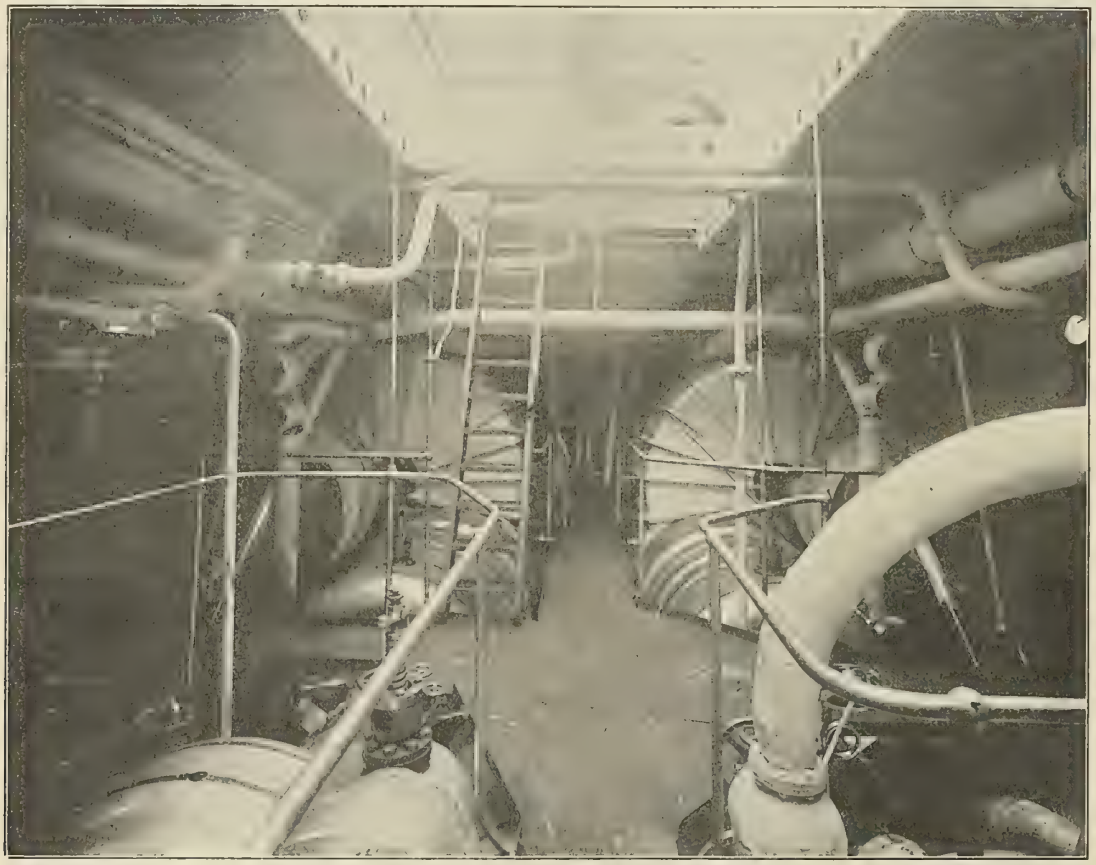
In each fire-room are two blowers, designed and built by the contractors. It is claimed that these blowers have given most excellent service, and have shown themselves capable of delivering air at 9 inches pressure in necessary volume. Further than this, each fan, with its engine complete, weighs less than 900 pounds.

The electrical plant consisted of one turbo-generator, furnished by the General Electric Company, together with switchboard, searchlight, etc.

The vessel was also fitted with the usual means of interior communication, telephones, bells, etc.

contractors. On Sept. 24 the twelve-hour trial at 24 knots was completed, and on Sept. 26 the full power four-hour run.

The standardization trial of the Reid was held on Oct. 6, and was to consist of the following runs, in the order given: Three runs at 12 knots, three at 16 knots, three at 24 knots, three at 30 knots, five at top speed, and three at 28 knots. Two extra runs were made at 28 knots, owing to a misunderstanding that the counters had broken down, which proved not to have been the case. On the afternoon of the same day the *Reid* left Rockland on her twenty-four-hour trial at 16 knots, completing this trial and arriving at the works of the contractors the next afternoon. The next day, Oct. 8, the twelve-hour trial at 24 knots was completed, and the following day,



INTERIOR OF ENGINE ROOM LOOKING AFT.

The contract specified that the vessels should be given standardization trials of not less than twenty runs over the mile, a four-hour full speed trial, on which the speed shown should average not less than 28 knots, a twelve-hour trial at 24 knots, and a twenty-four trial at 16 knots, and that the water consumption per shaft horsepower should not exceed 25.2 pounds on the 16-knot trial, 16.5 pounds on the 24-knot trial, and 15.5 pounds on the full-speed trial. All of these guarantees were met with a comfortable margin.

The standardization trial of the *Flusser* was held on September 21, over the Government mile at Rockland, Me., and was to consist of the following runs, in the order given: Three runs at 12 knots, three runs at 16 knots, three runs at 24 knots, three runs at 26 knots, five runs at top speed, and three runs at 28 knots. After entering the mile for the nineteenth run, however, fog shut in, and the balance of the runs were abandoned. The data, however, was sufficient to construct the speed curve. The next morning, Sept. 22, the *Flusser* left Rockland for her twenty-four-hour trial at 16 knots, ending this trial the next morning at the works of the

or the 9th, the four-hour full-speed trial was completed.

The following table gives the results of these trials:

	Flusser.	*Reid.*
Speed, fastest mile	33.67kts.	34.55kts.
Mean speed five high runs	32.67	33.75
Maximum shaft horsepower developed	14,400	15,140
Mean speed, four hours	30.41	31.85
Speed, best 15 min. during four-hour run	30.85	32.25
Revolutions necessary for 28 knots	706	700
Revolutions maintained four hours	801	846
Shaft horsepower during 4 hour trial, average	11,541	12,564
Indicated horsepower of auxiliaries during 4 hour trial, average	301	310
Total horsepower during 4 hour trial, average	11,842	12,874

The horsepower per ton of machinery, including spares and water, floors, gratings, handrails, ladders, etc., works out at 66, a figure which, so far as known, is a record.

No limit was placed upon air pressures on the standardization trials; the *Flusser,* carrying a maximum of 8 inches on

the highest run, and the *Reid* 5 inches in one fire-room and 6½ in the other. The contract provided, however, that an average of 5 inches should not be exceeded on the four-hour trials,and the 5-inch average was maintained but not exceeded on both vessels.

Both the *Flusser* and the *Reid* were equipped with Parsons vacuum augmentors, which performed very satisfactorily, as vacuums were maintained on both vessels at all speeds of between 28½ and 29 9/10 inches. These vessels are the fastest ever built in the United States, the fastest mile covered by the *Reid* being at the rate of 39.78 statute miles per hour. The builders are to be congratulated on having turned out such successful boats.

THE OPERATION AND CARE OF MOSHER BOILERS.

TO PREPARE A NEW BOILER FOR STEAMING.

Before steaming up a new boiler after it has been installed and has passed a satisfactory hydrostatic test, the manhole plates in the steam and water drums, as well as the cleaning doors in the casing, should be removed when the interior of the drums, casing and furnace should be carefully inspected to see that no tools, waste or other foreign matter has been forgotten and left about the boiler. Then the tubes should be thoroughly cleaned and washed out, the dirt being easily removed through the hand-holes in the water drums. All the interior fittings, such as dry pipe, feed distributing pipes, zincs and their baskets, scum pans, etc., should be carefully examined to see that they have not been disconnected but are secure in their proper places. Examine carefully all valves and fittings, particularly the safety valves, to make sure they are in proper working order. The seats and covers of manholes should be carefully examined, to insure alinement and freedom from foreign matter, in order to obtain a perfectly steam-tight joint.

From 2 to 3 pounds of salsoda, dissolved in water, should be put in the boiler for each 1,000 feet of heating surface, and then the boiler filled until the water shows a little more than half a glass when under steam. Note that the water shows a corresponding height by the gage cocks and gage glass.

A light fire may now be started, and the boiler boiled out for one or two hours under 100 pounds pressure. This will effectually cut off or dissolve all oils, grease, tallow and other foreign matter, after which the boiler should be blown down 3 or 4 inches by the surface blow, then filled to the previous height, and this operation repeated three or four times a few minutes apart. Finally, allow the boiler to cool down and the water to run out, or blow out, under low-pressure through the bottom blow-off valves. The object of cooling the boiler down before blowing it down is to prevent the baking on the surfaces of any sediment or other impurities by the heating of the boiler.

The boiler can now be refilled with fresh water till the glass shows about one-quarter full, which, when under steam, will show about half-full. Before lighting the fire see that the air cock is open, or other means for escape of the air from the interior of the boiler is provided.

GETTING UP STEAM.

Spread a light cover of coal over the whole grate, then build a wood fire on top of the coal and gradually add coal as the fuel becomes ignited until the required depth of fire is obtained, or if another boiler in the same fire-room is under steam a few shovels full of burning coal from it may be placed near the front of the furnace; the fire will then gradually creep back and may soon be spread over the whole grate. The ash-pan door should be wide open and the fire-doors slightly open when first starting the fire.

Under ordinary conditions the fire should be started about three-quarters of an hour before steaming, in order to enable a good bed of coal to become ignited. In cases of emergency, however, from fifteen to thirty minutes will be sufficient to raise full steam pressure if means are provided for forcing the fires.

The firing should be done regularly at frequent intervals, the fires being kept as thin as possible without forming air holes. Where a number of boilers are under steam, each having several fire-doors, it is preferable to fire the doors beginning on the right-hand side in succession on each boiler instead of firing all the doors of one boiler before proceeding to the next one.

Broadly speaking, firing may be divided into two classes—coking and sprinkling. The former is preferable for natural draft, and, if properly handled with the proper supply and distribution of air, should be practically smokeless. The air supply should be only slightly in excess of the theoretical amount required for complete combustion. The fuel should be fed at the front end of the furnace and gradually worked back by the firing tools. The coking action takes place when the fuel is banked at the front of the furnace subject to the radiant heat of the more active portion of the grate. The combustion of the gases is greatly assisted by the admission of pre-heated air, preferably delivered in the form of jets at high velocity into the furnace above the fuel. Means to supply air jets and means for pre-heating the air are always provided in Mosher boilers.

All parts of the fire over which the gases from the fresh fuel pass should be kept at a sufficiently high temperature to ignite them. At the same time the supply of air for the fuel should be delivered in the form of numerous jets at high velocity, in order to thoroughly mix the air with the gases and insure complete combustion.

The fires should be of even thickness and as thin as possible. Generally, they should not exceed 5 or 6 inches unless there is a very strong draft.

FORCED DRAFT.

For boilers running under forced draft, particularly where there is a fluctuating demand for steam, the sprinkling method of firing is more suitable. The fuel in this case is evenly spread over the entire surface of the fire in each of the charges, care being taken to fill up any holes.

The average depth of the fire with a draft equal to a column of water 3 or 4 inches high should not be over 8 or 9 inches. Naturally, the heavier the draft the heavier the fire, but it should be borne in mind that the thinner the fire the better the combustion, provided thin places and holes can positively be avoided.

If air is admitted into the ash-pan entirely through doors in the front end under heavy forced draft, its momentum carries it to the back end of the furnace with such force as to cause a very much greater amount of coal to be burned at the end of the grate, unless the fire is carried much thicker at that point. In some cases, the fire should be carried as much as 50 percent thicker at that end than at the end of the furnace nearest the door in order to realize an equal rate of combustion for all parts of the grate.

If the maximum steaming capacity is required, it can be more easily attained by keeping the largest possible area of the fire in an incandescent condition at the greatest possible heat. An extended front greatly assists in this case, as it enables practically all that portion of the fire under the tubes to be kept in an incandescent state, the radiant heat from which, it is admitted by eminent authorities, does fully 50 percent of the work.

SLICING FIRES.

No very definite instructions can be given for slicing fires, since this depends on so many variable factors. It is sufficient to say that it is necessary to slice the fires frequently enough to thoroughly break up the coking of the coal and distribute it so as to fill up any holes as well as to raise off from the grate any clinkers that coke on and prevent air from getting through. Of course, a dead place in the fire indicates that slicing is necessary.

CLEANING FIRES.

In cleaning fires when under way it is essential that the amount of grate surface put out of effective use at one time be as small as possible. Where there are a number of boilers it is best to burn down the fire in the boiler to be cleaned at a time when the fires in the other boilers are at their maximum heat. It is also advisable to clean only that portion of the fire opposite one door at a time, pushing the unconsumed portion of the fire on the adjacent side of the grate. Thoroughly remove all ashes and clinkers, after which the fire may be hoed back and spread evenly over the grates and covered with a thin layer of coal. Some interval, during which another boiler may be cleaned, should elapse before cleaning the next portion of the fire in the first boiler.

BANKING FIRES.

The fires should first be cleaned, the feed pump being allowed to run until the gage shows about three-quarters full. After cleaning, the fires should be pushed back and banked at the back end of the furnace, the ash-pan doors being closed and the fire-doors completely or nearly closed, as required.

If it is desired to keep the steam pressure up for a few hours, and the fire in such a condition that it can be spread and brought to its maximum capacity in a few minutes by the aid of forced draft, it is best to cover the banked fire with only fresh coal; whereas, if the fire is to be kept over night with only a low-pressure of steam, it is best to cover the banked fire with wet ashes and partly open the dampers in the stack, or open the doors into the up-take.

CLEANING BOILERS.

The best way to keep a boiler clean is to thoroughly purify the water from all scale-forming matter or other impurities before it enters the boiler. If this is not practical, and the interior of the boiler becomes coated with scale or other impurities, easy access can be had to all interior parts of the Mosher boiler. As many as fifty tubes may be examined, cleaned or replaced through each of the hand-holes in the upper portion of the steam drum. If there is an excessive amount of impurities in the boiler, the steam and water drums may be entered through manholes, and the interior of all the tubes conveniently cleaned by any of the ordinary tools.

To keep the exterior of the boiler free from soot and dust, the Mosher boiler is provided with cleaning doors for use when the boilers are not under steam, in addition to three soot-blowing pipes, permanently built in the boiler casing away from the heat, so that they will not be burned out. These pipes, which are of substantial size, run the whole length of the casing, and are perforated with four rows of holes, so arranged as to cause jets of steam to be blown over practically all portions of the boiler tubes. These pipes take steam direct from the boiler and are controlled by a single valve. By opening this valve two or three times a day the tubes can be kept clean and in a highly efficient condition.

PRIMING AND FOAMING.

It is claimed that Mosher boilers do not foam or prime with average good feed water, because of the very large steam drums with a great volume of steam space and large releasing area. Priming is usually caused by the production of more steam than can be released from the surface of the water level. In this case the whole surface of the water is literally heaved up to the steam outlet in sheets. Priming will also occur when the volume of steam space is too small, especially when supplying steam to very slow-running engines, which take large quantities of steam at widely separate intervals, causing a continuous surging of the water. Foaming is very apt to take place when first starting, or at any time, if the boilers are driven hard with forced draft. It may be due to dirty water, oil in the water or any alkali or soapy matter in the water. When foaming takes place in a properly managed boiler, checking the flow of steam will usually prevent it. If caused by dirty water or scum on the water, blowing down on the surface and bottom blows and pumping will usually cure it. In case of very violent foaming reduce the draft and partly cover the fires.

LAYING UP A BOILER.

If a boiler is not required for some time, empty and dry it thoroughly; this may be done by the use of brazier's torch, using gasoline, or a small charcoal fire may be started in each of the drums. After it is well dried out a quantity of quicklime should be placed in open pans, say 5 pounds to the pan, and left in each of the drums. Everything should then be closed up tight. The boiler should be opened at the end of a month, and if the lime is found slacked, it shows that moisture is present and the lime should be renewed. After this the lime should be renewed frequently, in any case every six months. If the boiler is only to be laid up for a short time, then fill it quite full of water, and put in a quantity of common washing soda (5 to 15 pounds, or 5 pounds for every 1,000 pounds of water) and close up tightly. All external parts exposed to dampness should receive a coating of linseed oil. The tubes or other parts of the heating surface that cannot be conveniently reached can be pretty well protected from corrosion by building a slow fire of tar or other resinous material. The tarry smoke will condense on the tubes and furnish protection from air and its moisture. Finally, close up the furnace, ash-pan and casing as tightly as possible.

REPAIRS.

Should a tube give out the fire should be drawn and the water removed from the boiler, after which the manhole covers may be removed from the steam and water-drums, giving access to all the tube ends. In case of temporary repairs the tube may be plugged by driving a tapered plug into the ends from both the steam and water-drums, the operation requiring but a few minutes. Whenever it is found convenient to replace the tube, after removing the manholes as above, and one of the hand-hole plates opposite the defective tube, the tube may be removed by splitting the ends with a diamond-point chisel, and then losening the ends with a tool known as an oyster knife. When the tube is loose it may be driven up from the water-drum end and then passed up through the hand-hole.

To replace a tube, the new tube is passed through the hand-hole and then through the tube sheets in the steam drum, until the lower end passes through the water-drum tube sheet about 1/4 inch, after which both ends may be expanded with an ordinary tube expander.

It is very important to keep the brick-work in good repair, as otherwise the casing may be warped or suffer other injuries. All bricks are secured with bolts, and any injury to the brick is localized to the brick affected, which may be easily replaced.

CARE AND HANDLING OF A ROBERTS BOILER.

To take care of a Roberts boiler and get the most out of it, it is only necessary to give it about one-half as good care and attention as you would a shell boiler. The main points to be borne in mind are that the water level should be kept at the proper height and the fire as clean and hot as possible. If these requirements are met the boiler will steam satisfactorily, with one proviso only; that is, scale must be kept out of the boiler.

The one enemy of all watertube boilers is scale. This, however, can easily be prevented, and in this connection everyone should remember that prevention is much easier than cure, mainly because prevention eliminates all the work necessary to clean the scale out, even if the necessary apertures are provided for the purpose. No such apertures, hand-holes, manholes or plugs are provided in a Roberts boiler, however, because the manufacturers claim that the formation of scale in the boiler can, and should, be prevented.

Of course, occasionally the soot should be cleaned off the outside of the coils if it forms to any extent from the use of soft coal or wood.

Since all parts of the boiler are built in duplicate and are interchangeable, repairs can be made quickly and with comparative ease. It is only necessary to remove any given section and replace it to effect any repairs. All joints are screwed joints, which the manufacturers claim are less liable to accidents than the expanded joints which are usually used in boiler work.

HOW TO GET THE BEST EFFICIENCY FROM A COCHRAN DONKEY BOILER.

The primary object of the donkey boiler is to relieve the main boilers of the arduous and exacting duty of discharging cargo and driving the auxiliary machinery when the vessel is in port. That the main boilers be kept in good condition, clear of dirt and scale, and not subjected to sudden changes of temperature, is the constant aim of the engineers in charge, and this can only be accomplished by devolving the dirty work upon the long-suffering donkey. The donkey, therefore, usually has to be content with water from the ship's side, as salt as the sea can make it, and perhaps, if the sea-cock is near the vessel's bilge, with a good supply of mud as well. Furthermore, it is invariably heavily overloaded. There is therefore much to be said regarding the handling of the donkey to get the greatest efficiency from it.

In the first place, let the donkey boiler be large enough, and let the same attention to cleaning it be given when it is off duty as is given to the main boilers. Its size must be considered in relation to the duty it has to perform. Not only must the size and number of winches to be driven be taken into account, but consideration must also be given to the class of cargo to be worked. Coal whipping and grain cargoes call for very strenuous work on the part of the donkey, particularly when working on the bottom half of the cargo. Steam is required in a continuous supply, and if the winches are in poor condition the strain is very great.

The following shows the amount of heating surface which has been found to give satisfactory results, and which should always be insisted on by owners. Even a still larger heating surface is well worth the slight extra money involved:

One 5-inch double-cylinder winch requires from 50 to 60 square feet heating surface.

One 6-inch double-cylinder winch requires from 80 to 100 square feet heating surface.

One 7-inch double-cylinder winch requires from 100 to 120 square feet heating surface.

One 8-inch double-cylinder winch requires from 140 to 160 square feet heating surface.

Having seen that the donkey boiler is large enough, the next point requiring attention is the position of the boiler in stokehole and the lead and size of the chimney. The boiler must be so placed that an ample supply of fresh air shall be available for combustion, and it is very important that a good ventilating shaft should be brought near to the front of the boiler.

More important still is the funnel. The donkey boiler must have a funnel of its own, the longer the better, and the same size as the opening on the top of the smoke-box. To reduce the diameter is absolutely fatal to the steaming capacity of the boiler. Again, if the donkey funnel is led into the main funnel it must be led to the top of it. There is no use merely leading a short length of funnel from the donkey to the main funnel, and expecting the main funnel to create a draft for the donkey boiler. Any draft created in the main funnel will only be drawn from the main boilers, or more probably still, from the main smoke-boxes, whose doors are often open when steam is off the main boilers.

The next point to consider is the feed water and the internal cleaning of the boiler.

As has already been pointed out the donkey boiler has to be content with salt, and often muddy, water, with the result that much scale is deposited on the heating surface. Provided that this scale is not allowed to get too thick, no undue overheating need take place, but it is imperative that it be removed at the very first opportunity available. It is also a *sine qua non* that the donkey boiler must be so designed that the scale can be readily removed and all parts of the heating surface be accessible for this purpose.

The cleaning of the donkey boiler should be attended to immediately after the vessel leaves port, and not left, as is so often the case, to the day before it is to be used again. It is quite possible that in the two or three days it may have been at work a deposit of ⅛ inch may have formed on the furnace, back tube plates and tubes, and this deposit will usually contain not only common salt and mud but a number of other ingredients, such as magnesium chloride and other hygroscopic salts, which are positively injurious to the steel and iron of which the boiler is constructed. These chemicals, in conjunction with damp heat, will often set up rapid corrosion in the tubes and plates of the boiler, and in a few years, or even less, serious trouble may accrue.

It is recommended that all this scale be removed at the very earliest opportunity, and after having been thoroughly washed out, the boiler should be carefully dried inside and made airtight by the shutting of all cocks and valves and the proper joining up of the manhole and mud-doors.

It cannot be too strongly borne in mind that, unlike the main boilers, the depreciation of the donkey boiler does not take place during the period it is under steam, but during the long periods when it is out of use, and the chemical scale and damp, hot atmosphere inside it are eating into its material during its idle time on the voyage.

Turning to the question of stoking, much sympathy must be bestowed upon the donkey man. His lot is not a happy one, for, as in the case of the donkey boiler itself, the impossible is too often expected of him. Feeling the hopelessness of doing what is wanted, the cruel logic of the situation seizes him, and he does not attempt it, and ends by doing even less than might reasonably be expected. The result is in all probability a dirty fire, sooty tubes, and, worse than all, a choked-up ash-pit, with the consequent overheating and dropping out of the fire-bars. To get the best results out of the donkey boiler it is imperative that the ash-pit be kept clear of ashes to allow of a copious supply of air to the under side of the fire.

PRACTICAL LETTERS FROM MARINE ENGINEERS.*

Experiences Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

Boiler Corrosion.

One of the most dangerous faults which may develop on board a steamship, after a certain amount of wear and tear, is the corrosion of the boilers, and a considerable amount of close attention and inspection is required in order to safeguard the boat against danger from this cause. Boiler corrosion is due to three main causes—air, acid and galvanic action. Of these the two former, air and acid, enter the boiler from the outside with the feed water, while galvanic action is set up inside the boiler by the heat and either alkaline or acid water acting on the different metals employed in the boiler.

Corrosion, however formed, shows itself in pitting and eaten surfaces, and it is usually found at points where the heat impinges on the boiler to the greatest extent. These surfaces are generally along the lines of the fire-bars on the water-side of the furnaces, on the sides, bottom and middle of backs of combustion chambers, also in a lesser degree on the combustion chamber stays nearest to the combustion chamber, and sometimes on the main stays nearest to the up-take end of the boiler. All of these parts should be very carefully examined when a boiler is laid off for repairs or while in dock. On the external surface of the boiler corrosion is caused by rust and by any burning of the heated surfaces which may take place. There is another kind of corrosion, technically called "grooving," which is sometimes found at the seams of the boiler, and is due to the mechanical action on the metal owing to expansions and contractions of the boiler.

In order to avoid the various types of corrosion mentioned above it is necessary to adopt certain precautions and remedies, which may be detailed as follows: It should be reckoned as an axiom that air should be excluded from a boiler as much as possible, as it tends to rust and corrode the plates. A most useful means of performing this is by the use of feed heaters, in order to thoroughly heat the water before entering the boiler. This not only drives off a large amount of contained air, but also, by sending the water into the boiler in a hot condition, tends to keep up a better circulation in the interior of the boiler; bad circulation is a very potent cause of corrosion of boilers, inasmuch as there is always a certain amount of oxygen in the water, which is liberated by heat. If a boiler has bad circulation this free oxygen attacks the metal plates and forms rust; whereas in a boiler possessing good circulation the free oxygen is detached from any surface upon which it may happen to rest and rises to the steam space.

In order to safeguard against exposed metal surfaces forming a favorable opportunity for rusting, new boilers should be lime-washed in the water and steam spaces before using, and if rust is found on the plates after the first running the lime-washing should be repeated. In the meantime a scale should be induced on the boiler plates by keeping the density low by means of scumming, and also by the use of lime added to the feed water. This, of course, should only be used in moderate quantity, as only a very thin scale is required in order to protect the interior of the boiler from rust.

It will be easily understood that acids attack boilers very readily, and these are brought into the boiler by the feed water. The chief source of this acidity is the decomposition of oil, which arises from a too frequent internal lubrication of the engine. Where lubrication is necessary only the best mineral oil should be used for the pistons and piston rods. Moreover, the gland packing should preferably be greased by mineral oil rather than with the tallow which is so frequently employed. Animal and vegetable oils always decompose in the high temperature of the boiler, and cause the formation of acids, whose action, if not checked, induces a great amount of corrosion and pitting. As pitting, if once started, is exceedingly hard to stop, the boiler water should be frequently tested for acidity by means of litmus paper.

If such boiler-feed waters are discovered to be acid by this test, soda or soda and lime should be added to the feed water, preferably in small quantities administered every day, although in engines which under regular conditions will run almost without internal lubrication the use of soda need not be so frequent. In one very bad instance of pitting and corrosion, a set of boilers which was attacked in this way was always opened out when in port and the corroded surfaces were scraped clean and washed with soda after being coated with lime-wash. This was done regularly, the result being that the pitting did not get any worse. In order to prevent oil from entering the boiler, even if it is necessary to use it in the engine lubrication, it is advisable to fit efficient oil filters in the feed-water service, so as to intercept any particles of oil before passing to the boiler. For seagoing practice, filters employing cores are the most suitable, as the filtering medium can be readily changed, even on the longest voyage.

One of the most fruitful causes of corrosion and pitting is galvanic action, and this is prevented by the use of zinc plates hanging in the water space of the boiler. These plates are attached to suitable hangers, having a proper metallic connection with the plates of the boiler. They should also be attached to the stays, furnace tubes and combustion chamber stays. Galvanic corrosion is thus transferred to the zinc, which is thus eaten away and the iron and steel preserved. It is found in practice that zinc plates are better than zinc balls connected to the boiler parts by wires, which is a frequent arrangement, inasmuch as the wires do not make a perfect connection.

It may be mentioned that although there are at the present time many liquids manufactured for the purpose of preventing boiler corrosion, these are not generally used in marine practice, and, generally speaking, it is hardly advisable to adopt them except under very careful skilled advice. Some of these liquids, as a matter of fact, do considerably more harm than good.

External corrosion of the boiler is a matter which can to a greater extent be more easily and immediately detected than internal corrosion. It can, as a rule, be prevented by keeping the mounting glands tight, and by seeing that the surface is thoroughly treated with a good composition or a covering of red lead and paraffin. The mattresses or boiler coverings should always be kept in good order and condition, and if attention is paid to these points of up-keep it is probable that the danger from corrosion will be very largely minimized, if not altogether obviated. A. H. S.

Circulating Valves.

The type of valve which is usually used on board ship for circulating pumps, ballast donkeys and bilge pumps is con-

* These letters are contributed by our readers and paid for at our regular rates.

structed of rubber, and the maintenance of these valves is a very costly item in the upkeep of a boat. On examination of such valves, after a period of running, it will be found that the part at which the valves wear to the greatest extent is at the center hole. This is easily understood from the fact that with the constant wear on the spigot bolt the hole gradually widens and wears too big until part of the ports in the valve seat are left open. In this way the vacuum of the pump is spoiled.

In order to obviate this difficulty a simple device has been tried which, as a matter of fact, has been found to increase the life of the valve roughly four times, and, therefore, causes a considerable saving. A piece of 1/32-inch Muntz metal is cut into a strip equal to the thickness of the valve. It is then bent round the spigot bolt, so as to form a loose fit and cut off accurately to length so as to form a true cylinder. This cylinder is then fitted into the center hole of the valve, and by means of this piece of strengthening metal it will be seen that the wear is now on the Muntz metal instead of on the valve, and a considerable saving is thereby effected.

Charles P. Starkweather.

Breakdown of a Reversing Gear.

In spite of the precautions taken to make the factor of safety of ships' machinery considerably in excess of any reasonable demand it sometimes occurs that mishaps happen, and in the case of the reversing gear this usually occurs at the most anxious time to the engineer; that is to say, when the boat is going into or leaving port. Such an accident may happen because the drain cock has not been opened and the water in the cylinder causes a breakdown to the gear. Possibly this is accompanied by the cutting away of the cylinder bottom, the fracture of the connecting-rod pin or the bending or fracture of the slide rod.

In most steamers the steam reversing gear can be operated by hand, but it will be realized that this is a very slow process. It is not by any means capable of use in working the ship into or out of port, as it is usually necessary to move the ship quickly.

A very rough but good plan to adopt in cases where any stoppage to repair the gear would be dangerous or expensive to the owners would be to take the L piece of a drilling standard, and clamp this on to the wheel as quickly as possible. By bringing two firemen from the stokehold to turn the wheel it is possible to handle the boat quickly, as this arrangement gives a good leverage, using the L piece as the handle. If there has been further trouble, such as bent rods, it is necessary, of course, to quickly discount these. R. A. Brush.

Overheated Tunnel Bearings.

Designers of marine engines and machinery sometimes forget that a steel steamer is to a certain extent flexible, and should be considered somewhat in the light of a lattice girder, which is alternately supported at the ends and in the middle. There is, however, this difference, that whereas the composition and loading of the girder are uniform, those of a ship vary from time to time. For example, a steamer when loaded with grain may take up a certain slight distortion, while in the same ship, when loaded with iron, an entirely different distortion may occur, a third condition arising when the boat is light.

This variation in the condition of the hull reflects itself in the varying degrees of attention which have to be paid to the bearings in which the propeller shaft runs. In one case, No. 1 or No. 2 tunnel bearing may run warm when the ship is loaded with grain, and when the ship is light the same bearings may run quite cool. As a matter of fact, in some boats which leave port with different cargoes it is impossible to tell which bearing is going to run warm. In one instance a bearing became so hot due to this cause that the white metal melted away.

In order to remedy this occurrence, if it happens at sea, a method adopted is to take a hardwood block and cut a small V in its center. This should then be wedged up under the shaft on either side of the bearing. There is always room for this to be done on the plummer block. When the weight of the shaft has been taken in this way on the wood block, it is safe to draw the bolts and take away the bottom brass, running this up again with white metal.

This may seem a rather risky expedient, but it very often happens that it would be very unwise to stop the vessel for such a repair, and if plenty of oil is kept on the block the shaft may be found to run quite well. It is advisable to have a hammer lying near the block, so that the engineer on watch going along the tunnel every hour may knock in the wedges as the hardwood block wears away. Experience.

Sewer Gas in Boilers.

When I was second engineer of an Atlantic liner sailing from the River Clyde, I had an experience which was interesting. Before the installation of the sewage-treatment plant at Dalmins, the Clyde used to become very "strong" in the summer months. We were lying at the quay during one of these periods, and I sent the third engineer to open up a valve through which we had been pumping Clyde water. He had an open lamp with him, and when he lifted the cover an explosion took place, and he was rather severely burned.

On making inquiries I found that this was not an isolated case, as I was told of an explosion which had occurred when taking off a condenser door. Probably a mixture of air and marsh gas made the explosive mixture.—*M. C. Gillean, in Power and the Engineer.*

Barcelona, Spain.

A Novel Steamship Repair.

An account of the replacement of a broken tail-shaft in the large steam tug *Dolphin,* belonging to Messrs. S. Pearson & Sons, is given by John Marshall, 14 West Bute street, Cardiff. He states that this vessel was lying in fairly deep water in the harbor at Sulina Cruz, on the Pacific Coast of Mexico. In the operation the propeller was first removed by a diver, and then the tail-shaft was drawn in towards the engine. To prevent the inrush of water, the diver slipped into the stern-tube a taper wooden plug, around which was an india rubber ring, to make it watertight. This was forced in and afterwards secured by means of a wooden chock wedged in between the head of the plug and the rudder post. The new tail-shaft was then put in place. Between the fore-and-after sleeve there were fitted wooden battens to make up the space between the sleeves, and to render the shaft of the same diameter throughout its length. These battens were kept in place by bands of copper wire laid in grooves prepared in the battens to receive them. When the new shaft was in the stern-tube the packing and the gland were replaced and screwed up sufficiently to prevent a rush of water. A jack was then placed at the inner end of the shaft, which was forced into its place, pushing out the plug from the stern-tube. The propeller was put on by the diver, and finally hammered up by means of a dolly slung and manipulated from the deck and guided below by the diver.—*The Steamship.*

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Boiler-Room Economy.

Economy in the boiler room of a steamship depends not only upon the design of the boiler, the design of the furnace and the quality of fuel used, but also upon the skill of the firemen and the care and management of the boilers. Obviously a well-proportioned boiler will not prove efficient if the heating surface is allowed to become coated on one side with a thick scale and on the other with a covering of soot and ashes. Neither will a well-designed furnace produce complete combustion if the fuel is improperly fired or the distilled gases prevented from mixing with the proper amount of air at a temperature necessary to support combustion. Above all, no problem of boiler economy should be considered by itself. It should be remembered that every factor entering into the design and operation of a steamship is more or less the result of a compromise; that, in fact, the entire vessel is essentially a compromise; and, consequently, every problem of economy should be considered in relation to the entire vessel, taking into account the limits of weight, space and cost available, and the purpose for which the vessel is to be used.

Two separate and distinct processes are carried out in a steam-generating plant: first, the combustion of the fuel; and second, the evaporation of the water into steam. There are many opportunities for losses in both of these processes, and, unfortunately, things which tend toward economy in one direction are frequently the very things which cause loss of efficiency in the other. For instance, in order to burn bituminous coal it is necessary to first distil the gases from the coal, then mix them with the required amount of oxygen and maintain a proper temperature for their combustion. For this reason it is an advantage to keep the gases at a high temperature in the furnace as long as possible. On the other hand, the evaporation of the water requires that the heat thus generated shall be extracted from the gases in the shortest possible time. In the present-day steam plant the former process has reached a higher degree of perfection than the latter.

As far as the latter is concerned, little is actually known regarding the rate of transmission of heat from hot gases through metallic surfaces to water. Rapid circulation of the water in the boiler and of the gases through the boiler apparently tend to increase the rate of evaporation, as has frequently been proved by the simple experiment of stopping up half of the tubes in a locomotive boiler and maintaining the same rate of combustion on the grate. Obviously the gases must pass through the tubes with twice the velocity, and the corresponding rate of evaporation per square foot of heating surface is doubled. This is accomplished without any great decrease in the efficiency of the furnace. Also, in a recent installation of stationary boilers two furnaces were installed under the same boiler, one at the front and one at the back. The result was that the evaporative power of the boiler was nearly doubled, with a loss in efficiency of only about 3 percent. Further corroboration of these results is found in recent experiments made by the United States Geological Survey, which seem to indicate that boilers should be made to do from ten to twenty times as much work per unit area of heating surface as they do now. This great increase is to be accomplished by forcing the hot gases through the boiler at a very much greater velocity than is now customary, as it has been found that the faster the gases travel parallel to the heating surface the greater the amount of heat which is transmitted from them to the water in the boiler, due to the removal of the cooled-off gas particles, which cling to the heating surface, forming a film which greatly retards the transfer of heat, and the bringing into con-

tact with the dry side of the heating surface other heated particles of gas. It is probable that improvements in design may soon be made along the lines vaguely suggested by the foregoing experiments; and if they are, even though they involve a decrease in efficiency in the steam-generating plant as such, due to the rapid combustion of large quantities of fuel, yet they would be readily welcomed for marine work, since they would undoubtedly permit a substantial reduction in boiler weights and space.

As we have previously stated, however, boiler-room economy does not depend entirely upon improvements in the design of boilers and furnaces. Skillful firing and the intelligent care and management of boilers are equally important. When watertube boilers were first being advocated for merchant vessels in the United States an installation of Belleville boilers was made in the passenger steamships *Northwest and Northland,* on the Great Lakes. These boilers gave considerable trouble for various reasons, and were subsequently replaced by Scotch boilers; but for one season the watertube boilers ran with a fair amount of success. This success was attributed to the fact that Spanish firemen were imported for working the boilers. The Spanish firemen were more or less familiar with this type of boiler, and were employed for the entire season, so they were able to become thoroughly familiar with their work, and since they were unable to speak English, they simply obeyed the instructions of the head fireman, who knew exactly how the boilers should be managed in order to get the best efficiency from them. Thus they were able to do what American firemen, who were only familiar with the firing of Scotch boilers and who rarely stayed on the ships long enough at a time to learn to fire the Belleville boilers, were unable to do. This is only one of many instances that might be cited to show the importance of proper firing in the economical management of any steam plant.

The importance of firing is brought out strongly in the various articles which we publish this month giving instructions for the care and management of different types of boilers in order to get the greatest efficiency from them. Undoubtedly Scotch boilers are the easiest to fire, for the grates are limited to practically uniform dimensions, and the height of the top of the furnace above the fire is so small that it is a comparatively easy matter to maintain an even depth of fire and to regulate it according to the nature of the draft, etc. With watertube boilers, however, not only are the furnaces usually much larger, but they differ radically in different types of boilers, due to the different directions in which the gases travel and the different means supplied for admitting air to the hot gases. Under such conditions it is a positive necessity that the fireman should have both good judgment and a good, practical knowledge of the special needs of the particular boiler on which he is working. Good judgment is required particularly when firing under forced draft with a closed stokehold, for under these conditions it is seldom that the fire will burn evenly all over the grate. "Light, even and often," is a rule often quoted to firemen, and it is a good one to follow, provided the fire burns evenly. The fireman should take pains to watch the fire carefully, however, and keep those places which tend to burn through more rapidly well covered, so as to prevent an excess of air from entering and spoiling the combustion. The sides and corners particularly should be given careful attention.

Mechanical stoking and oil fuel have frequently been proposed as the most logical means to escape the troubles and losses of efficiency due to poor hand firing. Mechanical stoking, however, means the feeding of a uniform quantity of fuel to all parts of the fire; and while this is satisfactory with natural draft, it becomes distinctly questionable with heavy forced draft in a closed stokehold where there is a tendency on the part of the fire to burn out more rapidly in the center. It may be possible to construct a stoker which will admit of sufficient regulation to overcome this difficulty, but at present they are not widely used for this purpose. Mechanical stoking, considered by itself, offers many striking advantages over hand firing; but when considered in the light of weight, space and cost in relation to the design of the entire ship, some of these advantages are eliminated and some serious disadvantages introduced. This is a matter, however, on which there has been little enough progress in the past, and which we hope to see given more attention in the future. Good results have already been obtained with some types of stokers in certain kinds of service, and these, we believe, will be steadily augmented.

Oil fuel, on the other hand, has proved quite generally successful, as evidenced by its use in naval vessels, and also its extensive use in merchant vessels running between ports where there are petroleum fuel-storage stations. On the Pacific Coast there are about one hundred and forty steamers using petroleum as fuel. Besides regular firing, easy control of the fires and the elimination of coal and ash handling, liquid fuel permits a reduction in the weight of fuel carried that tends directly towards economy not only as regards the boiler plant itself, but also as regards the design of the vessel as a whole. From the standpoint of absolute economy, therefore, oil fuel presents no disadvantages other than the cost of the fuel itself.

One more subject should be strongly emphasized in considering the question of boiler-room economy, and that is the importance of clean boilers. All scale and deposits should be removed from the heating surfaces at the earliest possible moment if their formation cannot be avoided. As far as possible, however, scale and deposits of any kind should be prevented from forming in the boiler.

Progress of Naval Vessels.

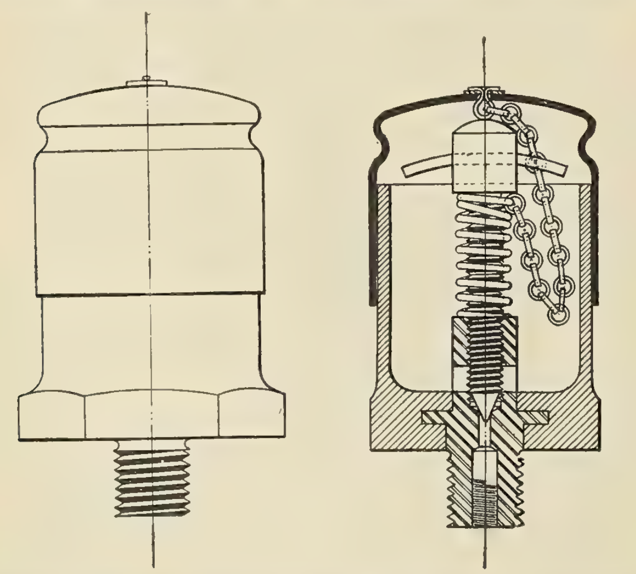
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Sept. 1.	Oct. 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons..........	98.0	99.0
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	94.8	96.8
North Dakota	20,000	21	Fore River Shipbuilding Co..	93.5	95.2
Florida	20,000	20¾	Navy Yard, New York......	29.2	33.7
Utah	20,000	20¾	New York Shipbuilding Co...	38.1	44.4
TORPEDO-BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons.........	96.4	98.4
Lamson	700	28	Wm. Cramp & Sons.........	90.3	91.4
Preston	700	28	New York Shipbuilding Co...	93.0	94.8
Flusser	700	28	Bath Iron Works............	92.4	100.0
Reid	700	28	Bath Iron Works............	89.6	94.3
Paulding ...	742	29½	Bath Iron Works............	27.3	36.3
Drayton	742	29½	Bath Iron Works............	24.6	30.5
Roe	742	29½	Newp't News Shipbuilding Co.	60.9	64.6
Terry	742	29½	Newp't News Shipbuilding Co.	58.5	63.9
Perkins	742	29½	Fore River Shipbuilding Co..	51.7	56.0
Sterrett	742	29½	Fore River Shipbuilding Co..	48.6	53.4
McCall	742	29½	New York Shipbuilding Co..	25.3	29.6
Burrows	742	29½	New York Shipbuilding Co..	25.4	29.2
Warrington..	742	29½	Wm. Cramp & Sons.........	39.1	47.3
Mayrant	742	29½	Wm. Cramp & Sons.........	45.2	51.5
No. 32......	...	....	Newp't News Shipbuilding Co.	0.6	1.1
No. 33......	...	....	Bath Iron Works............	2.2	4.0
No. 34......	...	....	Fore River Shipbuilding Co..	0.0	3.2
No. 35......	...	....	Fore River Shipbuilding Co..	2.5	5.3
No. 36......	...	....	Wm. Cramp & Sons.........	0.0	1.7
SUBMARINE TORPEDO BOATS.					
Stingray	...	..	Fore River Shipbuilding Co..	97.5	99.1
Tarpon	...	..	Fore River Shipbuilding Co..	98.8	99.1
Bonita	...	..	Fore River Shipbuilding Co..	92.0	99.0
Snapper	...	..	Fore River Shipbuilding Co..	92.0	99.0
Narwhal ...	...	..	Fore River Shipbuilding Co..	98.2	98.9
Grayling	...	..	Fore River Shipbuilding Co..	91.8	98.5
Salmon	...	..	Fore River Shipbuilding Co..	83.7	86.7
Seal	...	..	Newp't News Shipbuilding Co.	24.8	26.2
Pickerel			The Moran Co..............	8.4	10.7
Skate			The Moran Co..............	8.5	10.6
Skipjack	...	..	Fore River Shipbuilding Co..	0.0	7.6
Sturgeon ...	...	..	Fore River Shipbuilding Co..	*0.0	7.6
Tuna	...	..	Newp't News Shipbuilding Co.	3.0	3.8

ENGINEERING SPECIALTIES.

The U. S. Indestructicle Oil Cup.

The illustration shows both sectional and exterior views of a new indestructible oil cup, which is being manufactured and placed on the market by the United States Metallic Packing Company, Philadelphia, Pa. It is designed to have a maximum strength at a minimum cost. The shank of the cup is of machinery steel and it is consequently impossible to break it when screwing down the same, as is sometimes the case with the brass cup of similar design. The cover is of pressed steel and is attached to the body of the cup by a steel chain. This precludes the possibility of losing it by its jarring off, or, as is often the case with brass cups, from stealing.



The indestructible oil cup will be furnished either with a needle or wick feed, as may be desired, and with shanks of any desired diameter and number of threads. The standard cup, as shown in the illustration, has a ¾-inch diameter shank and 14 threads. The method of manufacture of this cup makes it possible to sell it at a low figure, and this, together with its mechanical features, will, it is believed, make it quite popular.

New Starrett Products.

Fig. 1 shows some new tool makers' buttons with screws and washers for jig work which have just been placed on the market by the L. S. Starrett Company, Athol, Mass. These buttons are hardened and ground to standard size, .400 by ½ inch, and are used to locate holes to be chucked and bushed for jigs where positive accuracy is required. In use the jig piece is laid out, prick-punched, drilled and tapped for button

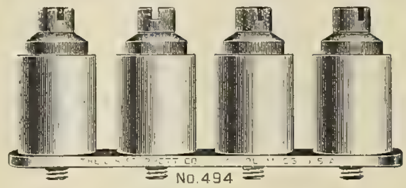


FIG. 1.

screws, and then the burr smoothed off. The buttons are then fastened on, strapping the pieces to an angle-iron, placing same on a surface plate, where, by aid of a surface gage, height gage, or other instrument, the buttons (with holes larger than the screws) are brought to the desired location. The angle-iron with the button pieces are then strapped to the lathe face plate, bringing one of the buttons to run true with the center. After this has been done, remove the button and chuck and ream the hole. The operation can then be repeated with the other buttons until all the holes are chucked.

Fig. 2 shows a new carpenter's scratch gage, which has just been placed on the market by the same concern. The head of this gage is made of steel with octagon-shaped periphery, case-

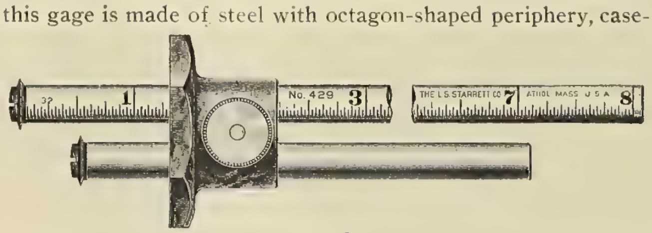


FIG. 2.

hardened. Two 5/16-inch bars, one plain, 4 inches long, and one graduated in thirty-seconds of an inch, 8 inches long, with rotating cutters on the ends, slide through the head. Either is adjustable in relation to the other, and may be used to make two marks at once, or, by slipping one back into the head

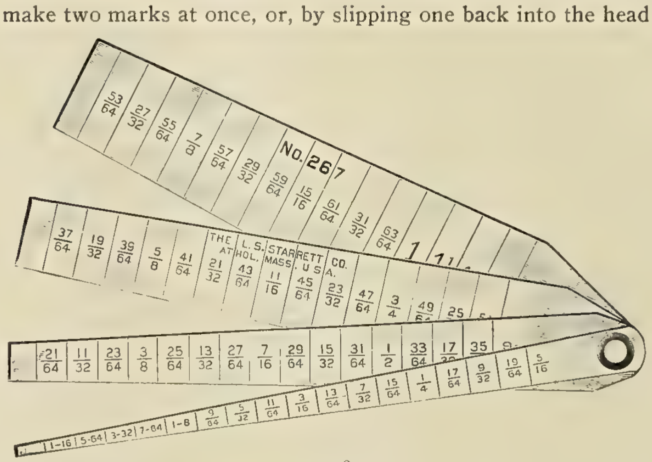


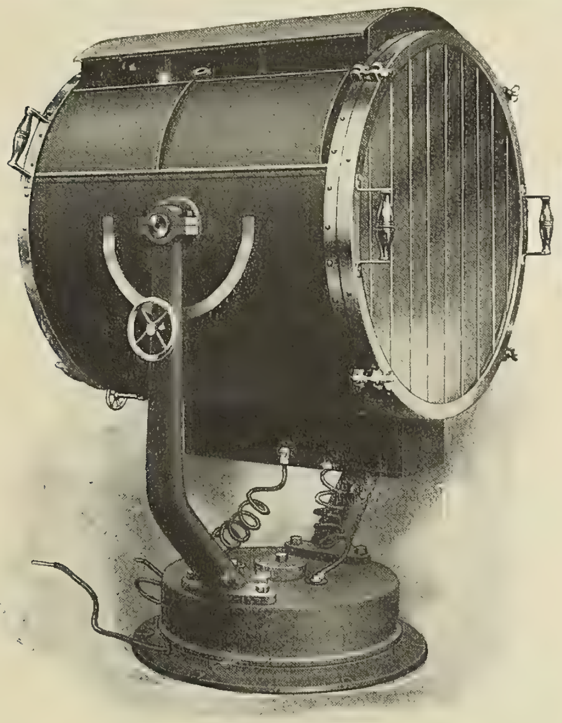
FIG. 3

out of the way, the other bar may be used for single lines. A single fastening screw holds both bars in position.

A new taper gage, in which the leaves are very thin and tapering, the width varying by 1/64 inch to every quarter inch of their length, is shown in Fig. 3. The leaves are graduated in quarter inches, and figured to read in fractions of an inch from 1/16 up to 11/16 inches.

Marine Electric Searchlight.

The Carlisle & Finch Company, Cincinnati, Ohio, has recently brought out several improved types of searchlights, which are particularly adapted for seagoing vessels. The type illustrated is a 32-inch projector of the hand-control type. This searchlight is very powerful, throwing practically a straight beam of light for several miles. It is fitted with a parabolic glass mirror, ground as accurately as possible, and is so supported as to allow for expansion from heat. These projectors are made in various sizes, from 7 to 38 inches diameter, and are arranged to be controlled from the pilothouse, or with distant hand-control rigging, or for hand control. It is claimed that the carbon-feeding mechanism is so reliable and so positive that it will burn in any position, and that it is not affected by the weather.



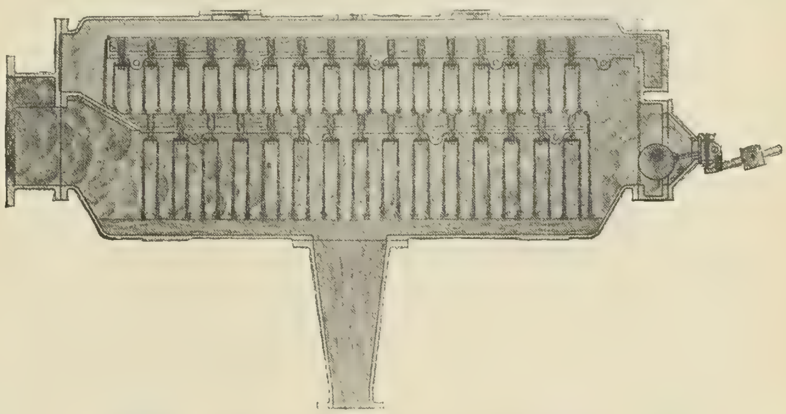
A New Form of Jet Condenser.

A new form of jet condenser has recently been placed on the market by the Wheeler Condenser & Engineering Company, Carteret, N. J. Referring to the illustration, the water is introduced at the upper right-hand corner into an extended trough or pan, from which it overflows through numerous short tubes, also at the edge on the extreme left, falling into a second and similar pan provided with similar overflow pipes and weir, and finally falling into the lower part of the shell and overflowing thence to the barometric column or to the centrifugal or other type of pump serving to overcome the atmospheric pressure.

The steam enters through the opening at the left, passes horizontally across through the shower of water, ascends to the second level, passes to the left through the upper shower, and finally all that is left of the steam vapor, together with the air and other gases, passes horizontally to the right and over the entering and coldest water at the top to the dry vacuum pump suction opening in the uppermost part of the shell. The cross-section of the passage traversed by the steam continuously diminishes as the volume of steam is reduced by condensation. Therefore, a uniform, steady velocity is maintained throughout, leaving no dead pockets in which air might accumulate.

From the illustration it will be seen that it is impossible for any of the steam to pass to the air pump suction without having traversed all of the space. The water is finely divided by the small baffles hung below the tubes. At the right of the illustration will be seen a float, controlling a vacuum-breaking valve. In case the water level should rise abnormally in the shell, due possibly to stoppage of the circulating pump, this will break the vacuum, upon which the inflow of water will cease, since the circulating water is syphoned up to the condenser head from a lower level. The steam would then escape through the relief valve.

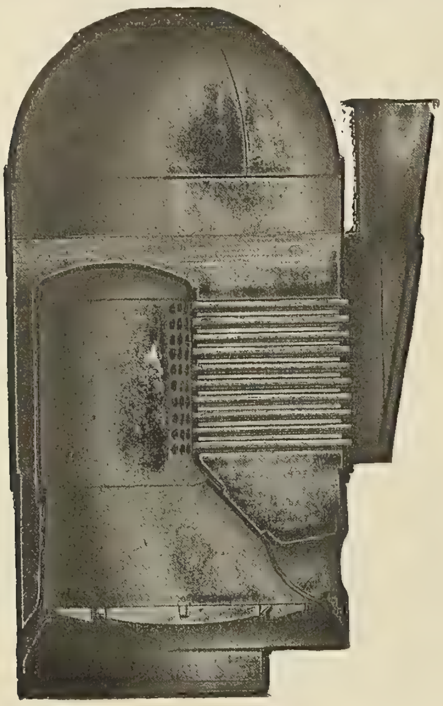
Tests made on this condenser in actual service show that the innovations briefly outlined above have worked to good advantage. Not only have the tests shown that extremely low vacua can be maintained, but also that the final temperature of the circulating water is very nearly that of the steam. In one test, where the injection valve was set to care for the maximum of a widely varying load, the outgoing circulating water was maintained within from ½ to 7½ degrees of the temperature corresponding to the vapor pressure.



Blake Patent Boilers.

The Blake Patent Boiler, built by the Blake Boiler, Wagon & Engineering Company, Ltd., Darlington, is very extensively used on steamships as an auxiliary boiler for driving the winches, etc., and on land for general purposes; it is specially adapted for utilizing the waste heat from furnaces. The chief requirements of boiler users of to-day are that the boiler shall steam quickly and easily with an economical consumption of fuel, and that it shall be easily accessible for cleaning and examination. It is claimed that the Blake boiler fulfills these requirements very easily; it has a large, spacious furnace and combustion chamber, in which the gases evolved from the fuel and the air can mix together, giving complete combustion. The gases pass from the combustion chamber to the smokebox through a large number of small tubes surrounded by water. The draft is quite free, and there is no necessity for wasteful steam jets to draw the gases to the funnel. The tubes are arranged with wide spaces between them, so that the passage of steam from the furnace and combustion-chamber plates and the tubes themselves is very much facilitated, thus promoting a rapid, positive circulation and abundant generation of steam. The boiler has great durability, because it is very accessible for cleaning purposes, consequently it can be

kept in an efficient and safe condition at a very moderate cost. Another special feature is its great strength, requiring neither screwed stays nor stay tubes. The circularity of the shell is not broken by the introduction of flat tube plates, and the boiler is consequently free from panting and the attendant



leaky parts. A special formation is imparted to the tube plates around the tube holes, whereby these parts are brought square with the tubes; thus oblique tube holes are avoided and a sound joint ensured by rolling with an ordinary tube expander.

No brick-work setting or expensive foundations are required for these boilers, and they are built in sizes from 9 feet high by 4 feet diameter to 18 feet 6 inches high by 8 feet 6 inches diameter.

Bronze, Brass, Aluminum and Babbit Metal for Marine Work.

The Vanadium Metals Company, Frick building, Pittsburg, Pa., has been organized for the purpose of manufacturing bronze, brass, aluminum and babbitt metals. This company has purchased the secret processes of the Victor Metals Company, of Massachusetts, which include Victor bronze, Victor vanadium bronze, Victor non-corrosive silver metal and Azalea antifriction metal. By the incorporation of vanadium in these compositions it is claimed that the strength and toughness has been wonderfully increased, and, as vanadium is a perfect scavenger, a very clean and uniform metal is insured.

Victor vanadium bronze has been used in all of the submarine boats built by the United States Government within the past few years, and also in foreign vessels of this type. In fact, this composition, or its equivalent, has been standardized by the Government for all the heavy castings in this type of vessel, where extraordinary strength is required. For cold-rolled plates, rods and wire the following figures are claimed:

	Ultimate Strength Per Square Inch. Pounds.	Elastic Limit Per Square Inch. Pounds.
Plates	95,370	76,940
Rods	92,090	80,070
Wire	101,000	83,180

Victor non-corrosive silver needs no introduction to the metal industry. It is claimed that it does not corrode when exposed to the elements or to acids of any description—vegetable or mineral—with the exception of nitric acid, and although easily polished to a bright silver color, is non-tarnishing, making it highly suitable and ornamental for all metal work on steamships, yachts, etc.

By the addition of vanadium in castings it is claimed that the tensile strength is increased to 65,000 pounds to the square inch, and the elastic limit to 45,000 pounds, thus making an ideal metal for all marine parts where great strength as well as non-corrosiveness is necessary, as this metal eliminates galvanic action of any kind whatever.

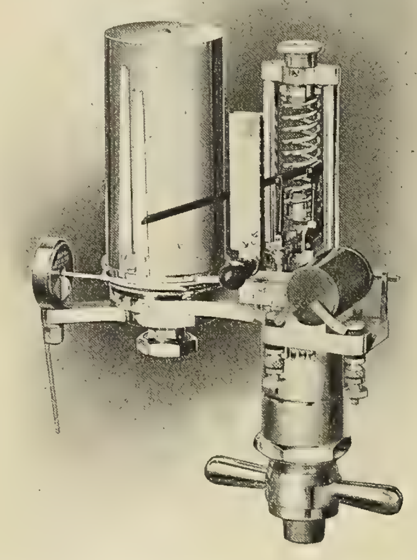
An aluminum is produced by the incorporation of vanadium, which is claimed to be 300 percent stronger.

A sheet-bar and rod mill is now under consideration, but its location has not yet been definitely determined. In the meantime arrangements have been made for the rolling of these metals and castings can be furnished up to 7,000 pounds of any of these vanadium metals.

INDICATORS.

The Tabor Indicator.

Recent improvements in the Tabor indicator, manufactured by the Ashcroft Manufacturing Company, Boston, Mass., consist principally in change of details rather than change of design. The main design, adopted many years ago, has been retained, but some new devices have been added and many of the details improved. The parallel motion of the Tabor indicator differs materially from others. A stationary plate, in



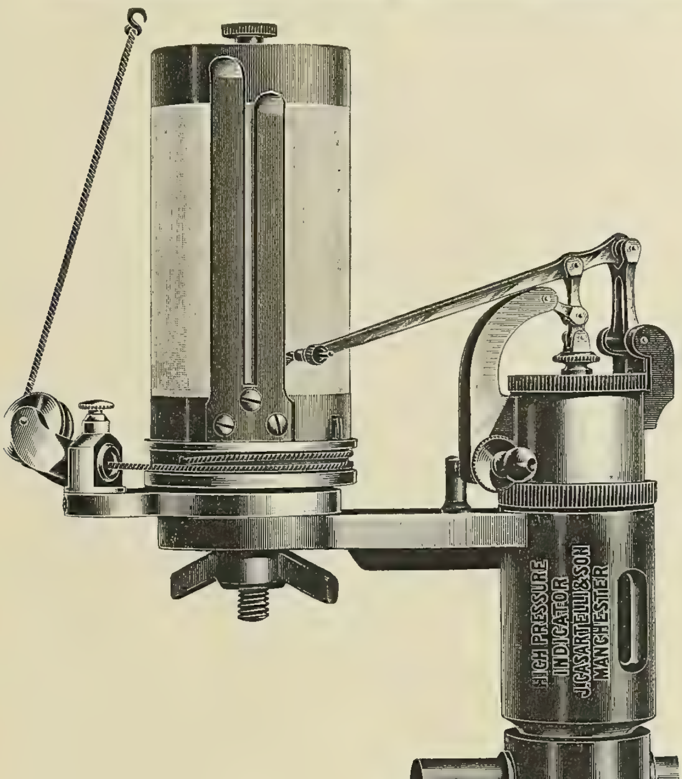
which is a curved slot, is firmly secured in an upright position to the head of the steam cylinder, or on the outside spring indicator, shown in the illustration, to a bracket on the steam cylinder. On the pencil bar is a roller bearing, which is secured to the bar by a pin. This roller moves freely in the curved slot in the guide and controls the motion of the pencil bar. The position of the slot and guide upright is so adjusted and the guide roller is so placed on the pencil bar that the curve of the guide slot controls the pencil motion, and, it is claimed, absolutely compensates the tendency of the pencil to move in an arc. This movement also involves a minimum of friction.

The springs used on these indicators are of the duplex type, made from two coils of wire attached exactly opposite to each other on the bases. This equalizes the side strain on the spring, keeping the piston centrally in the cylinder. It is claimed that the duplex springs are much more durable than either the single-coil or the single-wire double-coil springs, which are frequently used on other instruments. The springs are all made in different lengths, depending upon their scale, so that the atmospheric line is fixed by the spring itself without adjustment of any part. Provision is also made for a full and ample size vacuum curve.

The illustration shows a Tabor indicator with outside spring equipped with an electrical adjustment, and classed as the United States navy standard. The electrical adjustment is designed to facilitate taking cards upon several indicators simultaneously. The pencil points are operated by an electromagnet attached to each individual instrument.

The Casartelli Indicator

The Casartelli indicator, as now constructed by Joseph Casartelli & Son, Manchester, is the outcome of many years of practical experience in the manufacture of indicators from the old McNaught type, through the original Richards' type and its various improvements down to the present type, which has quite superseded all preceding ones. The object of the makers has been to produce a thoroughly sound, well made and reliable indicator, which shall fulfill modern requirements of pressures and speeds, at a moderate price, rather than a so-called "cheap" indicator, in which price is the first consideration.



The following are the special features of the indicator: The parallel motion is of the single link type, made specially light and strong of hardened steel, and multiplying the movement of the piston six times. The piston and rod are of hardened steel and ground, and fitted with a perfect ball joint at the base of the rod, making it impossible for the piston to stick in the cylinder. The cylinder is isolated from the body of the indicator, and has the casing cut open on one side to keep it cool, and to allow of lubrication when in use. The body of the indicator, the underside of the stage, and the coupling are sheathed with a special ebonite to allow of handling when hot. The paper barrel, or roller, is of improved design, and is fitted with a spiral spring to adjust the tension on the cord as required, and the pulley guide can be swivelled and clamped in any position desired. The springs are coiled, tempered and adjusted by a special and exclusive process, yielding what is claimed to be an absolutely even scale throughout, which is guaranteed to be correct. The manufacturers claim that the Casartelli indicator is especially adapted for marine use, as it is strong, compact, easily handled and cleaned, accurate and reliable.

VARIOUS TYPES OF THORNYCROFT BOILERS.

The Thornycroft boiler has been made in various forms. The *Speedy* type was first fitted (in units of large size) to H. M. S. *Speedy*, and consists essentially of a central upper steam barrel and two smaller lower-wing barrels. A series of generating tubes is fitted between the upper barrel and each wing barrel. These tubes are expanded in the ordinary way. The tubes form practically the whole of the heating surface, and the inner row on each side is curved in such a manner as to form the top of the combustion chamber, and so protect the upper barrel. Two down-comers, of ample size, are fitted at one end of the boiler. The tubes are so arranged as to ensure the gases passing over the whole of their surface.

The *Daring* type has two parallel barrels, one directly over the other, the upper being the steam and the lower the water-barrel. They are connected by eight or nine large down-takes, generally about 4 inches diameter, and also by two groups of generating tubes, each bounded by a pair of watertube walls. On either side of the lower barrels is a fire-grate. The two fire grates are each bounded on one side by one of the two groups of tubes and on the other by the watertube wall above mentioned. These tube walls are supplied with water by a pipe connected with the lower barrels and bent round on the outer side of the grate. The gases are made to go over the whole length of the tubes by setting the fire and outer rows so as to form flue ways.

The launch type was brought out soon after the *Daring* type, and is best described by saying that it consists of half a *Daring* boiler; but instead of the tube wall taking its supply of water from a separator barrel the tubes are bent round to form the fire-grate.

The Thornycroft *Schulz* type is a modification of the *Daring* type, but the gases, in order to more fully utilize the heat contained in them, are led through specially constructed passages. The flames enter the central nest of tubes at the bottom along its whole length. The drums are connected by special down-comers.

The modern *Speedy* type is being used in most navies for both coal and oil fuel, and consists of an upper steam barrel and two smaller cylindrical lower-wing barrels. A series of generating tubes, slightly curved at the ends to allow of free expansion, connects the upper and lower-wing barrels. The curvature also allows the tubes to be put into the drums radially, thus saving weight and also allowing a cylindrical-bottom barrel to be adopted. Down-take tubes are fitted at the end of the boiler. The modern *Speedy* type of boiler is well adapted for the use of oil fuel, as a large combustion space can be obtained, and owing to the curvature of the tubes distortion does not take place under the great heat and high rate of evaporation obtained.

In connection with all the above types a Thornycroft feed

regulator is used. This is fitted in the upper barrel, and consists of a float, which rises and falls with the water level. This is suitably connected to a valve, throttling the admission of feed water if the level is high and admitting it freely if the water level is low. Another rod comes through the front of the boiler to allow of hand regulation.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

929,564. BOAT PROPELLER. SAMUEL T. CRAWFORD, OF BALTIMORE, MD., ASSIGNOR OF ONE-HALF TO WILLIAM GREEN, OF BALTIMORE, MD.

Claim 1.—In a boat propeller, in combination, a clamp for attachment to a boat, a gear frame, a propeller frame, a tube connecting said frames and held in said clamp, said tube being mounted in said clamp for axial adjustment, a driving shaft passed through said tube and having its end portions journaled in said frames; gear means supported by said gear frame for driving said shaft, a propeller shaft having a bearing in said propeller frame, a propeller carried by said propeller shaft, and a driving connection between said driving shaft and said propeller shaft. Ten claims.

920,284. FLOATING DRYDOCK. WILLIAM THOMAS DONNELLY, OF BROOKLYN, N. Y.

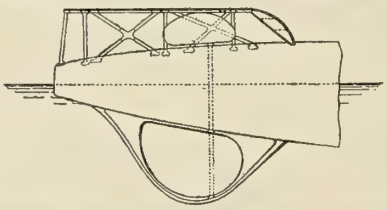
Claim 2.—In a floating drydock, pontoons, sides or wings mounted on top thereof, eyes on each side of said sides or wings, eyes on said pontoons, links, and pins designed to engage said eyes and links and connect said links to the pontoon and sides or wings. Six claims.

922,137. ANCHOR. MILAN W. HALL, OF BROOKLYN, N. Y., ASSIGNOR OF ONE-HALF TO ALFRED W. JANSEN, OF NEW YORK, N. Y.

Claim 1.—An anchor comprising a shank, a mushroom head of substantially elliptical form, and a fluke arranged to project substantially in the line of the minor axis of the ellipse of the mushroom head. Nine claims.

922,298. SUBMARINE OR SUBMERSIBLE BOAT. CESARE LAURENTI, OF SPEZIA, ITALY, ASSIGNOR TO FIAT-SAN GIORGIO, SOCIETA ANONIMA, OF SPEZIA, ITALY.

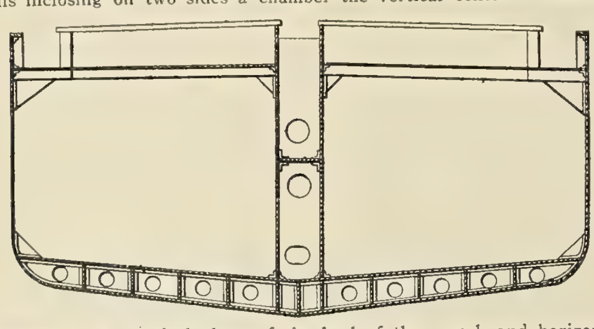
Claim 1.—In combination with a boat for submarine or submersible navigation, a permanently attached plane surface at the stern arranged



above the propelling means and at such a height above the line of flotation when the boat is navigating above water as not to be subject to the force of the waves. Four claims.

922,903. HULL CONSTRUCTION FOR VESSELS. EDWARD S. HOUGH, OF SAN FRANCISCO, CAL.

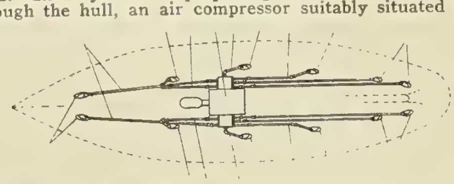
Claim 1.—A vessel having a pair of longitudinal, parallel, spaced walls inclosing on two sides a chamber the vertical center of which is



arranged in the vertical plane of the keel of the vessel, and horizontal floors or partitions subdividing said chamber into superposed compartments.—Three claims.

927,996. SYSTEM FOR PROPELLING VESSEIS. THOMAS MOTTON, OF TORONTO, ONTARIO, CANADA.

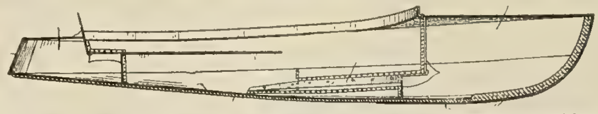
Claim. 2.—In a system for propelling vessels, of a plurality of outlet ports through the hull, an air compressor suitably situated in said hull,



conveying tubes or conduits communicating between said air compressor and said outlet ports, gate valves arranged in said conveying tubes or conduits adjacent to said outlet ports, a valve cylinder arranged in combination with said gate valves, tubular conduit connections between said valve cylinder and said air compressor, and means for operating said valve cylinder and gate valves by compressed air. Eight claims.

926,252. SHEET-METAL BOAT. GEORGE H. HYDE, OF WATERTOWN, N. Y.

Claim.—In a sheet-metal boat duplicate sets of sheet-metal plates forming the sides and bottom of the boat, those of each set being dis-

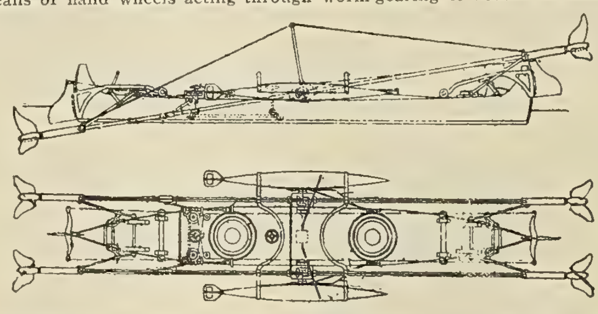


posed one above the other, the upper section gradually diminishing in width from its ends toward the center, and a lower section gradually increasing in width from its ends toward the center, the adjacent lengthwise edges of the plates of each set being of substantially the same length. One claim.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

25,108. TORPEDO BOATS. R. MINIUSSI AND J. G. BLANCH, BUENOS AIRES, ARGENTINA.

A torpedo boat is fitted with two propeller shafts having propellers at both ends and so mounted that the rear or the forward propellers may be submerged at will for running forward or astern. The shafts are carried in bearing-bosses freely mounted at the ends of the cross-shaft coupled to the engine, and are stiffened by folding struts and tie-rods. The tilting of the shafts is effected by an operator in a turntable by means of hand wheels acting through worm-gearing to rotate the cranks



connected to loose sleeves on the shafts. The rudders are raised and lowered by the shafts, but so as to leave the water later and enter it earlier than the corresponding propellers. The steering is controlled by the operator through hand wheels, worm-gearing, and chains. The torpedos are carried in clamps mounted on frames, which are freely mounted on the outside of the bosses and are connected across the boat by arms. The launching is effected by a second operator seated in another turntable by means of a pivoted lever provided for each torpedo. The successive movement of the lever acts, first through a link to incline the frame and start the motor of the torpedo by a starting device thereon coming against a fixed lug, and next through a link which acts on arms to open the parts of the clamps. The torpedo then enters the water, and a further movement of the link causes a rack to engage a wheel and open a valve for admitting compressed air into a collapsed chamber normally held between the torpedo and the clamps, so as to maintain the stability of the boat. The turntables are mounted on roller bearings, and are provided with a cover of waterproof fabric fitting round the operator's waist. To prevent water from entering the boat around the turntable, an annular ring of rubber is secured at its inner edge to the turntable, and is provided at its outside edge with a beading which is secured by a spring ring clamp. The clamp ring may be raised sufficiently to allow the turntable to rotate without the beading escaping.

25,904. MAGNETIC COMPASSES. G. P. ASHBURNER, AND G. F. HARVEY, LIVERPOOL.

Relates to electric means for indicating when a ship leaves her set course. A contact on the compass card is set to lie between two contacts carried by the inner and outer parts, respectively, on the inner gimbal ring, these parts being insulated from one another. The outer gimbal ring is in two halves insulated from one another and the current flows through the pivots when the card swings in one direction or the other. A contact dipping into a mercury cup on the card completes circuit in each case.

26,441. CLEANING SHIPS' HULLS. SHIP CLEANING COMPANY, AND W. R. MACDONALD, LONDON.

A number of flexibly-connected battens carry wire mats constituting a cleaning device for ships' hulls. The battens are held against the hull electro-magnetically. Solid plates are provided having their faces more sharply curved than the slope of the wire bristles. The magnets are situated in recesses in the battens, which are only partly closed by plates; cooling water is therefore able to circulate around the windings, which are insulated by rubber or other suitable material. The parallel battens are connected by chains and may be further divided along their length to enable the mat to conform more readily to the contour of the hull. In order that the mat may be easily placed in position, it is maintained in a vertical position in the water by a number of corks attached to the upper edge, or by lead attached to the lower edge.

27,715. COMPARTMENTS; CARGO BOARDS. R. MACGREGOR, HOBOKEN. LEZ ANVERS, BELGIUM.

A vessel of ordinary exterior construction is provided with inner longitudinal bulkheads, extending upwardly and inwardly from a watertight flat, situated at or about the upper turn of the bilge, to the deck. By this construction, a main cargo space is formed in which central shifting boards are not necessary, and also side spaces, which may be utilized for cargo or water-ballast. A watertight flat is fitted in the side spaces at some distance above the bilge. The tonnage space of the hold may be varied by arranging inclined removable boards supported on bearers, sloping from the floor of the hold towards the bulkheads.

27,810. SHIPS. N. ILIINE, ST. PETERSBURG, RUSSIA.

In a pumping system for emptying ships' holds, the pumps in the various holds or compartments are coupled to water wheels or turbines, which are driven by high-pressure water from a main. The high-pressure service may also be utilized for fire-extinguishing purposes.

International Marine Engineering

DECEMBER, 1909.

UNITED STATES BATTLESHIPS DELAWARE AND NORTH DAKOTA.

The trials of the two 20,000-ton American Dreadnoughts *Delaware* and *North Dakota* were carried out during the latter part of October and the first part of November over the Government course at Rockland. These two battleships were authorized in 1906. The *Delaware* was built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., and the *North Dakota* by the Fore River Shipbuilding Company, Quincy, Mass. The two ships are sister ships, and are exact counterparts as regards their principal dimensions and main features, but the *Delaware* is propelled by twin screws, driven by triple-expansion reciprocating engines, and the *North Dakota* by twin screws, driven by Curtis turbines. Each ship is 510 feet long on the waterline and 518 feet 9 inches long over all. The beam is 85 feet 2⅝ inches and the mean draft 27 feet. The normal displacement is 20,000 tons, and the full-load displacement 22,075 tons.

In outward appearance the modern tendency in warship design is at once apparent in these ships. The Dreadnought idea of armament, with all big guns of a single caliber, is fully carried out, there being ten 12-inch 45-caliber guns mounted in pairs in revolving turrets on the center line of the ship. Much of the superstructure which was formerly visible in battleships is absent, and only a minimum amount of exposed area is visible with the exception of the guns themselves and their turrets. The appearance of the ship is further modernized by the use of the skeleton framework, fire-control masts, now standard in the United States navy, separate elevated searchlight platforms and the absence of any bridge decks except the single conning tower and navigating bridge.

As can be seen in the photograph, the vessels have a high forecastle deck and a wide flare above the waterline at the bow, qualities which should make for seaworthiness in heavy weather. The freeboard forward is 27 feet. The guns in the two forward turrets are, therefore, brought to an exceptional height above the waterline, the forward pair being 33 feet and the pair immediately aft 41 feet above the normal waterline. One of the after turrets also has an elevation of 33 feet above the waterline, enabling its guns to be fired over the two aftermost turrets, which are at such a height that their guns are 25 feet above the normal waterline. This arrangement of the main battery is one which is being copied to a certain extent by other navies, and which has much to recommend itself. All the guns have an exceptionally wide arc of fire, and all can be fired on either broadside. The fore-and-aft fire is limited to four 12-inch guns, whereas most of the English Dreadnoughts are able to bring six guns to bear directly ahead or directly astern. A very small angle of deviation from right ahead or right astern, however, is sufficient to bring this number down to four.

U. S. S. NORTH DAKOTA LEAVING BOSTON HARBOR FOR HER TRIALS OVER THE ROCKLAND COURSE.

In addition to the main battery of big guns there are fourteen 5-inch rapid-fire guns for anti-torpedo boat attack, four 3-pounders, four 1-pounder semi-automatics, two 30-caliber machine guns, and two 3-inch field guns. There are also two 21-inch submerged torpedo tubes.

These battleships are among the most completely armored in the world. The main belt, which is 7 feet 6 inches wide, is 10 inches thick at its bottom edge and 12 inches at its upper edge. Above this, amidships, is a second belt, 8 feet wide and 10 inches thick at its bottom edge and 8 inches thick at the top. The main turrets and barbettes are protected by 11-inch armor, and the battery of 5-inch guns, which is mounted on the gundeck, by a belt of 5-inch armor.

Both ships were designed for a speed of 21 knots, the designed horsepower being 25,000. Twelve Babcock & Wilcox watertube boilers are used in each case. The normal coal supply is 1,016 tons, and the maximum 2,340. Oil fuel is also provided, to be used in conjunction with the coal.

One of the most important points about these vessels is the opportunity afforded for an exact comparison of the two types of propelling machinery, which is made possible by the simi-

larity of the two ships. Details of the engines of the *Delaware* are not available, and only very general reports of her official trials. We are able, however, to give a somewhat more extended description of the turbine engines of the *North Dakota,* and a fairly detailed account of her trial trip.

A very complete description of the *North Dakota's* turbines was published on page 184 of our May, 1909, issue, but a brief recapitulation of the main points may not be out of place here. The turbines were designed to develop 12,500 horsepower, each at 245 revolutions per minute, with a steam pressure of 265 pounds per square inch in the steam chest and 28 inches vacuum in the exhaust shell. Each turbine is 144 inches pitch diameter, and 22 feet 6 inches long center to center of the main bearings. The expansion of the steam is divided into nine stages in the ahead turbines and two stages in the reverse turbines, the ahead and the reverse turbines being incorporated in the same casing.

In the first expansion stage of the turbines there are four rows of moving buckets on the wheel, since the greater energy drop in this stage produces a greater velocity of the steam jet from the nozzles, which requires more rows of buckets to properly absorb the energy at the bucket speed used. One-fourth of the available energy of the steam is expended in the first stage and three-thirty-seconds in each of the other stages. This is done in order to keep the pressure in the shell as low as possible. It requires, however, that the first-stage nozzle shall be of the expanding type, while all the other nozzles are of the parallel-flow type. The moving buckets for the sixth, seventh, eighth and ninth stages are all mounted on a single drum, there being three rows of buckets to each stage.

The reverse wheels are mounted in the after end of the casing, and, under ordinary conditions, when the turbine is running ahead, they are in a vacuum, and therefore do not waste power by steam friction. Cast steel steam chests for ahead and astern running are attached to the front and back casing heads, and are flanged for main steam pipes 13½ inches in diameter. The exhaust is through a rectangular opening, 4 feet by 10 feet, in the top of the casing at one side of the center line.

A regular marine thrust bearing is attached to the forward end of the turbine shaft, the thrust block forming an extension of the forward main bearing. In addition to taking any unbalanced thrust which may occur, this bearing also maintains the proper axial position of the rotor, so that the axial clearance of the blades is correct. This clearance is about 1/10 inch on the first wheel and increases as the size of the blades increases. The thrust bearing is placed at the forward end, so that any unequal expansion of the shaft and casing will be allowed for at the after end, where the clearance is largest.

OFFICIAL TRIALS OF THE U. S. S. NORTH DAKOTA.

	**3 Hours of Full Power Trial.	24-Hour Trial at 19 Knots.	24-Hour Trial at 12 Knots.
Actual average speed	21.64	*19.24	12.05
Revolutions per minute	280.4	231.9	143.2
Shaft horsepower of main turbines	31,400	*16,710	3,800
Indicated horsepower of engineer's auxiliaries	1,100	*660	400
Water rate of main turbines only	13.6	14.11	20.5
Water rate for all engineer's purposes based on total horsepower	13.96	15.29	22.3
Coal used, pounds per hour	54,400	*27,550	9,820
Coal used, tons per 24 hours	583	295.3	105
Coal per hour per shaft horsepower of turbines	1.74	*1.65	2.56
Coal per hour per horsepower for total horsepower	1.68	*1.58	2.34
Coal per hour of equivalent indicated horsepower based on 8 percent friction for reciprocating engine	1.55	*1.46	2.15

* All preceding figures are official except those starred.
** At the end of three hours a boiler tube burst, necessitating the cutting out of four boilers.

The steam pressure at the forward end of the drum approximately balances the thrust of the propeller, so that the thrust bearing is only required to take the resulting unbalanced thrust, which is comparatively small.

The principal results from the official trials of the *North Dakota* were as shown in the tables.

STANDARDIZATION TRIAL.	Knots.
Highest speed on mile, uncorrected for tide	22.25
Mean of five high runs	21.83
Revolutions per minute for 21 knots	263.
Revolutions per minute for 19 knots	228.8
Revolutions per minute for 12 knots	142.5
Maximum shaft horsepower developed on mile	35,150.

POUNDS OF WATER PER HOUR PER HORSEPOWER FOR THE CURTIS TURBINE SPECIFIED AUXILIARIES.

	Specified.	Actual.	Saving, Percent.
3 hours of full power trial	15.1	13.96	7.5
24-hour 19-knot trial	16.1	15.29	5.0
24-hour 12-knot trial	23.2	22.3	3.9

Aside from her attainment of a full power speed of 21.64 knots, as compared with 21 knots specified, the most noticeable feature of these trials is the remarkably low coal consumption, particularly at slow speed, and the steaming radius made possible thereby. With maximum displacement this figures 9,000 nautical miles at 12 knots speed, while it is 4,600 nautical miles at 19 knots speed, and 3,000 nautical miles at a maximum of 21½ knots speed.

Compared with her sister ship, the *Delaware,* equipped with reciprocating engines, the *North Dakota,* with Curtis turbines, required only 295 as against 315 tons of coal per twenty-four hours on the 19-knot trial, and 105, as against 111 tons, on the 12-knot trial.

The trials of the *Delaware* were carried out just previous to those of the *North Dakota,* and with the following results:

On the four-hour full-speed trial, steaming with forced draft, the engines developed 28,600 indicated horsepower, driving the ship at an average speed of 21.56 knots. The maximum speed for 1 mile was 21.98 knots. During the four-hour trial, unofficial figures indicate that the average revolutions of the engines were 127, the coal consumption per indicated horsepower working out at 1.8 pounds, and the water consumption of the main engines at 13.5 pounds. The mean speed for five separate runs over the measured mile was 21.44 knots, with a corresponding horsepower of 28,578.

Of course, in comparing the horsepower of the reciprocating engines and turbines the difference between brake-horsepower and indicated horsepower must be kept in mind, the former being in the neighborhood of 88 percent of the latter. One fact is particularly emphasized in the performance of these two vessels, and that is the possibility of forcing turbine engines far beyond their designed power. In a turbine-driven ship every ounce of steam that can be generated can be applied to propulsion, vastly increasing the power of the turbines, and, consequently, the speed of the vessel; whereas, on a ship driven by reciprocating engines, it is not uncommon for the boilers to generate more steam than can be used by the engines, and hence it is impossible to get as good results from forcing.

Due to the lack of official figures, it is impossible to compare the steaming radii of the two vessels at various speeds. It is claimed, however, that at 12 knots the *Delaware* has a steaming radius of 9,300 nautical miles, whereas the *North Dakota* has a radius of only 9,000 nautical miles. Similarly, at 19 knots, the figures are 5,400 for the *Delaware,* 4,000 for the *North Dakota,* and at a speed of 21 1/7 knots 3,170 for the *Delaware* and 3,000 for the *North Dakota.*

THE DESIGN OF REVERSING ENGINES.

BY EDWARD M. BRAGG, S. B.

Reversing engines are required upon marine engines of any size. While the smaller engines may be reversed by hand, the attempt to do this in engines over 1,000 indicated horsepower would necessitate such a large multiplication of power that the operation would be too slow for safety.

Some of the types of reversing engines employed are shown in Figs. 1 to 4. There are two general types, the direct acting, shown in Figs. 1, 2 and 3, and the all round, shown in Fig. 4.

In Fig. 1, *A* is the steam cylinder, *B* is the oil-brake cylinder, *C* is the valve chest containing the valve which governs the admission of steam to *A*, and *D* is the valve chest which contains the valve governing the flow of oil from one side of the piston to the other. The oil cylinder is used to prevent the gear from getting too much momentum, and so doing damage when it is necessary to reverse quickly. It also causes the gear to move smoothly. Fig. 5 shows a section through the valve chest *C* of Fig. 1. In this case a piston valve is used for both steam and oil. The steam is taken in

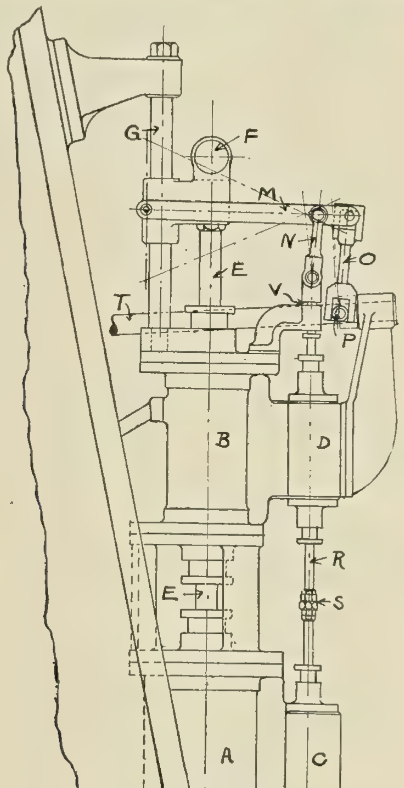


FIG. 1.

the middle of the valve and it exhausts at the ends. More commonly a slide valve is used, in which case the steam is taken at the ends of the valve and exhausts in the middle. The piston valve is so made that it overlaps the edges of each port by 1/16 or 3/32 inch. When no oil cylinder is used, as in the gear shown in Fig. 2, the exhaust lap is usually made larger, so that considerable compression may be obtained at the end of the stroke and produce the cushioning that the oil would. In the case of the valve for the oil cylinder the laps must be no more than are necessary for oil tightness, as the gear will be locked as soon as the valve closes.

In some cases the steam valve is made "line and line," or with no lap at all, and occasionally with a clearance. This is done when it is thought necessary to have the steam acting upon the piston in the "ahead" position to keep the links from working over towards mid position. Referring to Fig. 5, it will be seen that if we attempt to make a negative steam lap on the valve there shown by lengthening or shortening the valve stem with the adjusting nuts *S*, we shall increase the steam lap on the other end of the valve and throttle the steam when going from the "head" position to the "astern" position. In fact, it would be possible by this means to put so much clearance on the "ahead" position that the valve would not open the port to the other end of the cylinder.

The displacement of the valve is usually much less than the width of port. In Fig. 5 the lap of the valve is 3/32 inch, the width of the port is ⅞ inch, and the clearance is ¼ inch, so

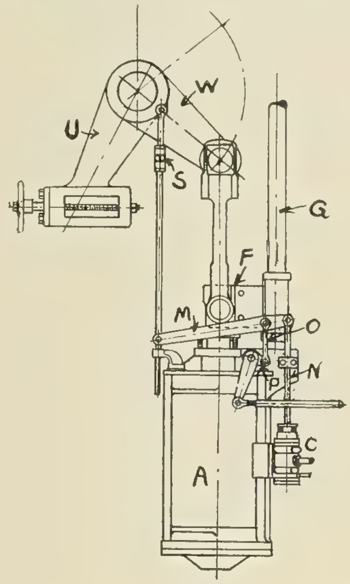


FIG. 2.

the maximum port opening of the valve is 5/32 inch. If the valve stem length were altered at *S*, Fig. 1, so that the lap on one end was increased from 1/32 to ¼ inch, the valve would not open at that end. This maximum port opening is made small so that the links will stop moving almost as soon as does the reverse lever. The greater the maximum port opening the longer the links will keep moving after the reverse lever stops. The first movement of the reverse lever takes up the clearance at *V* in Fig. 1, and then it cannot move further until the crosshead commences to move. By following up the crosshead with the reverse lever the valve is kept open, and then when the lever is stopped a very slight movement of the crosshead brings the valve back to its mid position. The link *O* is placed where it is most convenient, and the lengths of the bell-crank levers made such that the movement of *O* is to the movement of the crosshead as the distance of *O* from the floating lever *N* is to the distance of the crosshead from that lever.

In the Brown gear shown in Fig. 3 the pitch of the coarse thread corresponds to the longer arm of the lever *M* in the other gears, and the pitch of the fine thread corresponds to the shorter arm. The crosshead *N* corresponds to the floating lever *N* in the other gears. This type usually has an oil cylinder above the crosshead *F*, and the upper end of the valve spindle *M* is attached to the valve of the oil cylinder, and regulates the flow of oil from one side of the piston to the other. The diameter of the oil cylinder is usually made about two-thirds of the diameter of the steam cylinder.

It will be found usually that the diameter of the reversing engine cylinder is from .2 to .185 the diameter of the low-pressure cylinder of the main engine. It will vary with the

boiler pressure, steam speeds and eccentricity. The reversing engine takes its steam from the main steam line between the boiler and the throttle valve, so as to have steam even when the main engine is shut down. The size of the piston should be such that with .9 the boiler pressure there will be a twisting moment exerted equal to twice that for which the reverse shaft was designed. If the steam speeds are low the piston valves will be larger in diameter and the slide valves will be broader, so the frictional work to be overcome in moving the valves will be greater. The greater the eccentricity the greater the distance through which the valves must be moved. Some consideration should therefore be given to these three conditions in settling upon the size of the reverse cylinder. The stroke of the reversing engine is usually about 2.5 the travel of the valves, but varies from two to three times this amount.

The reversing engine lever, or levers (see *W*, Fig. 2), in going from the ahead to the astern position, must move through the same angle as do the reversing levers *V*, and the length of the former should be such that the angle be-

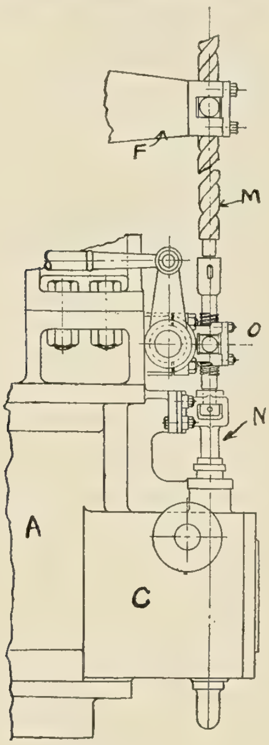


FIG. 3.

tween the extreme positions is subtended by a line whose length is equal to the stroke of the reversing engine. If Θ is this latter angle, and s is the stroke of the reversing engine, the length of the reversing engine lever will be:

$$l = \frac{s}{2 \sin \Theta} \qquad (1)$$

The piston rod can be calculated by the formula given for piston rods in the chapter on "Marine Engine Design." The formula is as follows:

$$D^2 = \sqrt{\frac{0.48\ F\ C\ l^2}{10{,}000{,}000} + F^2} + F \qquad (2)$$

$D =$ diameter of rod in parallel part.

$F = \dfrac{2\ W}{\pi\ f}$

$W =$ load on rod.

$f =$ allowable stress per square inch $= C/N$.

$C =$ ultimate strength of material $= 60{,}000 - 75{,}000$ pounds.

$N =$ factor of safety $-$ 15.

$l =$ length of parallel body of rod in inches $=$ stroke $+$ diameter of cylinder.

The connecting rod can be calculated by the formula[2] given in the same article for connecting rods:

$$D^2 = \sqrt{\frac{1.08\ F\ C\ l^2}{10{,}000{,}000} + F^2} + F \qquad (3)$$

All the quantities are as above except that $N = 12$, and the length of the rod is usually from 1.5 to 2.5 the length of the reversing engine lever. This length must suit the position of

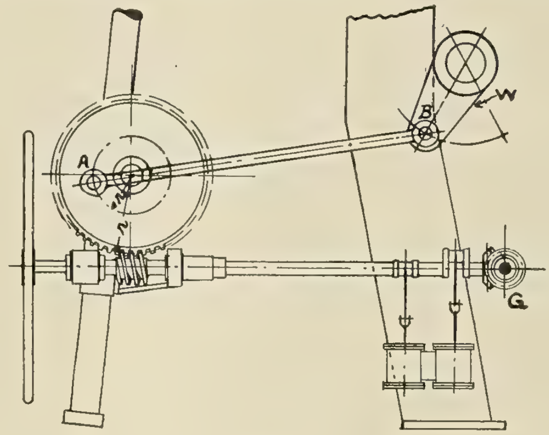


FIG. 4.

the cylinder relative to the reverse shaft. When an oil cylinder is used and the crosshead is above the oil cylinder the rod will have the lower value given; when the crosshead is between the two cylinders, the length may exceed that given above. The maximum force transmitted through the connecting rod will be slightly greater than that transmitted through the piston rod, due to the angle which the former makes with the center line of the engine at the middle and ends of the stroke. This increase is so slight, however, that

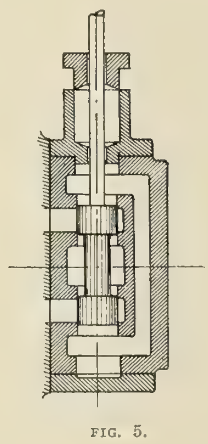


FIG. 5.

it can be neglected and the rod calculated for the same load as the piston rod. The diameter of the rod at the ends can be reduced to .85 of the diameter at the middle.

The pressure upon the crosshead pin can be as high as 3,000 pounds per square inch, since the connecting rod moves through a very slight angle, and the engine will not be used with sufficient frequency to heat the pin.

The crosshead guide is usually a circular rod, and should be designed to resist the bending that will come upon it when the piston is at the middle of its stroke. The center line of the engine is so placed that the connecting rod will swing

through equal angles on either side. The maximum load coming upon the guide will be:

$$w = \frac{r - \sqrt{r^2 - (s/2)^2}}{2 \times l} \times W \qquad (4)$$

r = length of the reversing engine lever.
s = stroke of reversing engine.
l = length of connecting rod.
W = load upon piston rod.

The pressure per square inch on the crosshead guide should be from 60 to 80 pounds.

In the All-round gear shown in Fig. 4, the radius r should be about 2.5 times the eccentricity of the valves, and the radius r of the pitch circle of the worm should be such that with the pitch used the number of teeth on the worm wheel will be between 30 and 45. A less number than 30 gives weak teeth and more than 45 makes the time of reversing rather long. With 30 to 45 teeth the reversing engine will have to make from 15 to 23 revolutions to throw the links over if a single-threaded worm is used. The design of worms and worm wheels has been taken up under the head of Turning Engines, and some of the formulæ there given for the small worm and worm wheel can be used here.

Referring to Fig. 4 it will be seen that

$$\frac{T}{l} = \frac{mep \times a \times 2s \times r \times e \times e_1}{p\ r_1} \qquad (5)$$

and if $a = \dfrac{\pi d^2}{4}$, and $p = \dfrac{2 \pi r}{n}$,

$$d^2 s = \frac{4\ T\ r_1}{l \times mep \times n \times e \times e_1} \qquad (6)$$

T = twisting moment in inch pounds on reverse shaft necessary to throw all the gears.
l = length in inches of reverse engine lever.
mep = mean effective pressure in cyliders of gear.
a = area of cylinder in square inches.
s = stroke of engine in inches.
r = radius of pitch circle of worm wheel in inches.
r_1 = eccentricity of pin A in inches. (See Fig. 4.)
p = pitch of teeth in inches.
n = number of teeth on worm wheel.
e = efficiency of worm.
e_1 = efficiency of engine.

Formula (15), page 426, gives the stress at the root of the teeth of the worm wheel:

$$f = \frac{4.2\ F}{C_1\ p^2}$$

Formula (8) in the same issue gives:

$$F = .96\ Z \frac{1}{p};$$

and from (7) in the same issue:

$$Z = mep \times a \times s.$$

Therefore, $$f = \frac{4.03\ mep \times a \times s}{C_1\ p^3} \qquad (7)$$

From formula (5):

$$mep \times a \times s = \frac{T\ p\ r_1}{2\ l\ r\ e\ e_1}$$

Therefore, $$f = \frac{2.02\ T\ r_1}{C_1\ p^2\ l\ r\ e\ e_1} \qquad (8)$$

There seems to be no reason why f should vary inversely as the efficiencies of the gear and of the engine. Referring to formula (6), page 426, it will be seen that F is a function of these efficiencies. The presence of e and e_1 in the denominator of (8) will therefore cause the expression to be independent of these quantities. Assuming that $e = .4$ and $e_1 = .8$, we have:

$$f = \frac{6.3\ T\ r_1}{C_1\ p^2\ l\ r} \qquad (9)$$

Therefore, $$p = \sqrt{\frac{6.3\ T\ r_1}{f\ C_1\ l\ r}} \qquad (10)$$

p, T, r_1 r and l are as above.
f = allowable stress at root of teeth.
= 3,500-4,000 for cast iron and 5,000 for cast steel.
C_1 = breadth of wheel at root circle in terms of the pitch. C_1 is usually about 2.

(To be Concluded.)

APPLICATIONS OF ELECTRICITY TO PROPULSION OF NAVAL VESSELS.*

BY W. L. R. EMMET.

The figures and statements given in this paper are not mere theories based upon supposed possibilities, but in all essentials are accomplished facts, the nature of the case being such that we need not go beyond the scope of our actual experience to accomplish the purposes here proposed. These plans are actual designs worked out in every significant detail, which might be, and, if opportunity offered, would be contracted for and fully guaranteed.

The data and information given relate to two distinct methods, both adapted to the propulsion of battleships of the design of the *Arkansas* and *Wyoming*. Either plan is fairly indicative of possibilities in other war vessels, although each case must be designed on its merits if the best results are to be expected. In the first of these methods, which will be spoken of as "Combination Drive," generating units with motors and low-pressure turbines on propeller shafts are used together and separately for different conditions. In the second method, called here "Electric Drive," the propulsion is wholly by electric motors. The first of these plans was made the subject of a proposition to the Government for one of the new battleships, the turbine part being designed by the Fore River Shipbuilding Company and the electrical part by the General Electric Company. The second has been designed since the bids for these ships were opened.

In both of these designs the steam conditions specified by the Navy Department, namely, 260 pounds gage and 50 degrees F. superheat, have been used in calculating results. In both cases vacuum diminishing with load from 28.5 inches at 12 knots to 27 inches at 20.5 knots has been assumed. The Parsons curves given have been taken from guarantees without knowledge of vacuum proposed. If the vacuum is better than 27 inches, the Parsons water rates at the high speeds should be higher than those given by curves.

COMBINATION DRIVE.

With this drive it is proposed to use twin screws and to install upon each propeller shaft a low-pressure turbine and an electric motor, both of these being installed in the engine room provided for in the design of the ship. We would also install in each engine room a high-speed steam turbine generating set. The capacity of the generators and motors would be such that they would be capable of delivering, at 20.5 knots,

* Read before the Society of Naval Architects and Marine Engineers, New York, November, 1909.

TABLE I.—COMBINATION DRIVE.

Knots	12	13	13	14	14	16	18	20	20.5	21
Shaft horsepower	4,400	5,500	5,500	6,900	6,900	10,450	15,350	22,700	26,000	30,700
Sum of motor output	4,400	5,500	5,500	6,900	6,900	8,750	10,000	11,250	11,700	12,350
Low-pressure turbine output	....	....	....	....	....	1,700	5,350	11,450	14,300	18,350
Number of poles on motor	42	42	42	42	28	28	28	28	28	28
Motor speed	131	142	142	153	153	175	198	224	232	240
Motor efficiency	94.5	95	95	95.5	95.5	95	95	95.5	95.5	95.5
Vacuum	28.5	28.5	28.5	28.5	28.25	28	27.75	27.25	27	27
Generator speed	1,400	1,510	1,510	1,625	1,085	1,250	1,370	1,580	1,645	1,710
Number of generators	1	1	2	2	2	2	2	2	2	2
Flow and leakage	52,300	62,700	67,000	82,500	92,000	133,700	195,700	276,300	315,000	366,500
Water rate for motor output	11.9	11.4	12.2	12.0	13.3	15.25	19.7	24.75	26.9	30.3
Low-Pressure Turbine										
Bucket efficiency	....	....	....	....	....	50	52	58	59.5	60
Flow	....	....	....	....	....	37,800	114,000	221,000	274,000	348,000
Water rate per shaft horsepower	....	....	....	....	....	22.2	21.4	19.30	19.1	19
Horsepower output	....	....	....	....	....	1,700	5,350	11,450	14,300	18,350
High-Pressure Part of Turbine.										
Bucket efficiency	....	....	....	....	....	61	64	67.5	69	70
Bucket water rate	....	....	....	....	....	30.5	29	27.5	27	26.6
High-pressure flow	....	....	....	....	....	39,700	119,500	232,000	288,000	365,500
Motor output	....	....	....	....	....	1,070	3,620	7,500	9,550	12,350
Motor output from cond. part	....	....	....	....	....	7,680	6,380	3,750	2,150	....
Corresponding flow	....	....	....	....	....	93,000	75,200	44,300	26,000	....
Total flow, including leakage	52,800	63,500	68,500	84,600	93,500	133,700	195,700	277,300	315,000	366,500
Water rate per shaft horsepower	12	11.6	12.5	12.2	13.5	12.8	12.75	12.25	12.1	12

two-fifths of the total power required for propulsion. The remaining three-fifths of the power under these conditions would be delivered by the low-pressure turbine, which at such a time would receive steam exhausted from the generating unit. This low-pressure turbine would also be fitted with two reversing stages, similar to those which would be adopted with direct-turbine drive. The low-pressure turbines would also be so arranged that they could take high-pressure steam from boilers through separate nozzles, and with such supply they would act as fairly efficient high-pressure turbines. With such high-pressure steam supply the ship would make a speed of about 19 knots with the same steam required for 20.5 knots with the combination drive.

This turbine has two exhaust openings, one connecting to the second stage and the other to the fifth stage. When the ship is running at about 20.5 knots all the steam would pass through the first of these exhaust openings to the low-pressure turbine, its pressure between the two being about 50 pounds absolute. When the ship operates at speeds below 15 knots the low-pressure turbine would not be used at all, the power being delivered to the propellers entirely by motor and being all generated by the high-speed turbine. At speeds between 15 and 20.5 knots, a part of the steam would pass to the condenser through the low-pressure turbine, and part through the lower

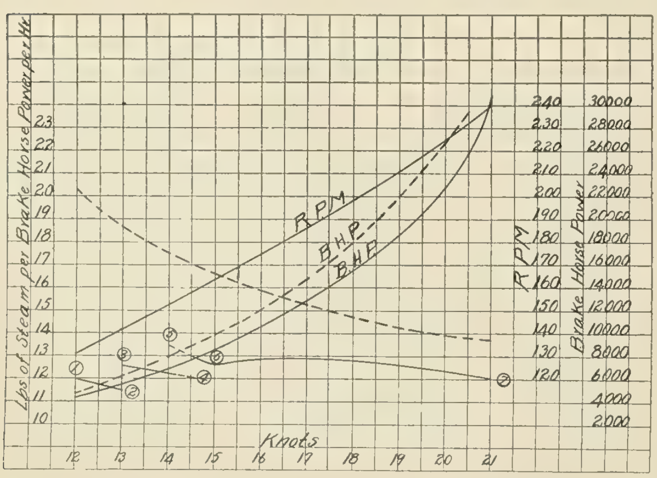


Fig. 1.—Curves showing steam consumption with combination drive compared with guarantees on Parsons equipment for the same ship. Also power curves for both cases and propeller speed curve for combination drive. Dotted lines, Parsons drive; full lines, combination drive; line 1-2, one generator and motors connected for 42 poles; line 3-4, one generator and motors connected for 28 poles; line 5-6, two generators and motors connected for 28 poles; line 6-7, combined effect of motors and low-pressure turbines. At 7, all steam passes through low-pressure turbine, at other points only a part.

stages of the high-speed turbine. The design of generating unit provides for a valve by which any desired number of third-stage nozzles can be closed, and by this means the division of steam between the low-pressure stages of the high-speed turbine and the low-pressure turbine can be controlled.

The curve sheet, Fig. 1, and the accompanying tabulation show all the relations of speed, power and efficiency.

It will be seen that in this plan the electrical apparatus acts simply as a speed-reducing bond between the generating turbines and the propeller shafts. The motors are not used for reversing, and are of the simple, squirrel-cage induction type. The voltage is low and the arrangement of generator and motor constitutes the simplest known means of electrical power transmission. With such apparatus, insulation trouble or mechanical trouble is practically unknown, and there is no other form of mechanism which can accomplish such results with equal simplicity and certainty.

Since in a warship it is desirable to operate efficiently at low speed as well as at high, the motors proposed in this case are so arranged that they can be connected either for 28 or 42 poles. In the higher-speed ranges the 28-pole connection is used, and in the lower-speed ranges we use the 42-pole connection. This change of connection is made by a single movement, which actuates a group of toggle switches, so designed that their action is perfectly positive and dependable. These switches could be so arranged that they could not be moved when the circuit was energized, so that no trouble could result from opening or closing them under load.

In this arrangement the electrical apparatus, with high-speed turbine, constitutes an auxiliary, the purpose of which is to improve efficiency under all speed conditions, and particularly to adapt the ship to economical operation at cruising speed. These results it will accomplish without the introduction of any feature which can be considered problematical. Turbine generating units exactly equivalent to that proposed are being widely used with better efficiencies than those here assumed, and motors of similar character, size and speed are delivering uniformly successful work under the most difficult conditions, such as mine hoisting, rolling mill work, etc., and mechanical or electrical trouble with either class of apparatus is of inappreciable extent.

This combination plan, as here explained, was decided upon largely with a view to overcoming the doubts and fears which might be raised by the proposition to introduce such a novelty into the new battleships. The arrangement might have been made lighter and less expensive by adapting the motors to reversal so that the reversing turbine could be left out. This would have necessitated changing poles in the ratio of 2 : 1 in-

stead of as proposed, but the results obtainable with suitable designs would have been nearly the same. The reversal accomplished in this way would have been just as quick and effective as that afforded by the reversing wheels. Another feature of this scheme which it was hoped might allay the doubts and fears of uninformed persons is the fact that it could be readily convertible into a direct turbine drive.

ELECTRIC DRIVE.

Since the completion of these designs for combination drive and their rejection by the Government, the writer has designed an equipment somewhat similar in principle, in which the whole power is delivered to the propeller shafts by means of motors. On each propeller shaft it is proposed to install two motors, one of which is arranged with pole-changing switches, so as to adapt it to use at lower speeds, this motor being similar in character to that proposed with the combination drive. The other motor is adapted only to the smaller number of poles used with high speeds, and is arranged with a resistance connection to its motor so that it is suitable for producing the high torque desirable in quick changes of the ship's direction. The generating units proposed in this case are of a type representative of the highest development which has been attained. They are designed to give a very uniform efficiency through wide ranges of load and speed, so that they will accomplish the various functions desired with the best general effect. The voltage of these generators and motors is such as to give the simplest and most dependable windings for apparatus of the size, the maximum potential generated being about 2,200 volts.

The results in steam consumption at different speeds obtainable by this equipment are shown in Fig. 2. The water-rate curves there given refer to the propelling machinery alone, and do not include any other steam consumptions. The dotted curves on the same sheet show guarantees made on Parsons turbine equipment for the same ship. These Parsons curves presumably make some allowance over the results expected. It will be observed that the Parsons power curve is considerably higher than that assumed for the electric or combination drive. A large part of this difference is, however, certainly attributable to the fact that the proposed Parsons equipment operates with four propellers and much higher propeller speeds, which will give a lower efficiency to the propellers themselves and a lower propulsive efficiency of the ship, since one propeller is bound to interfere with the action of the other. The water-rate curve given for the Parsons equipment seems fairly reperesentative of the results claimed for the best Parsons designs. It agrees closely with the curve of water rates calculated for the Curtis turbine for a similar ship.

TABLE 2.—ELECTRIC DRIVE.

Knots	12	14	15	15	18	20	20.5
Shaft horsepower	4,400	6,900	8,600	8,600	15,350	22,700	26,000
Motors, number of poles	50	50	30	30	30	30	30
Motor speed	131	153	164	164	198	224	232
Motor efficiency	94.5	95	96	96	96	96	96
Motor power factor	60	65	83	79	84	85	85
Generator speed	1,105	1,295	830	830	1,005	1,130	1,172
Vacuum	28.5	28.25	27.50	28.25	27.75	27.25	27.0
Number of generators..	1	1	1	2	2	2	2
Number of motors.....	2	2	2	4	4	4	4
Pounds of water per shaft horsepower...	12.3	11.8	12.55	13.4	12.25	12.1	12.3

Propeller Speed.—In designing this electric drive we have adopted, for the sake of comparison, the same propeller speed used with the combination drive, and this in turn was taken for a similar reason from that proposed for direct propulsion by Curtis turbines. In the combination drive it will be desirable to keep to the best Curtis turbine speed, since a large proportion of the power is delivered by turbines. In the electric drive, however, we are not limited as to propeller speed,

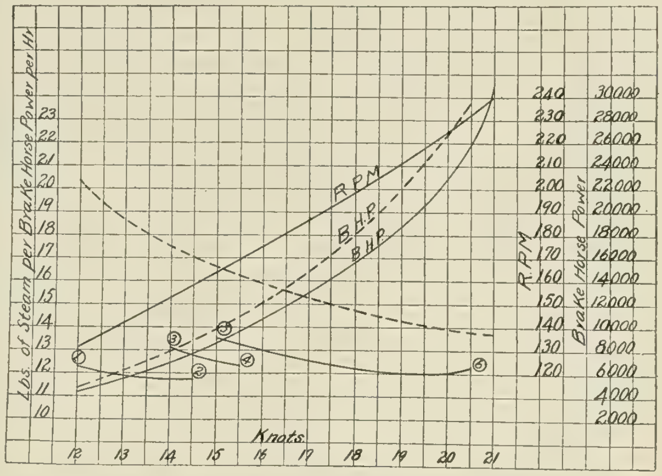


Fig. 2.—Curves showing steam consumption of electric drive compared with results guaranteed on Parsons equipment of the same ship; also power curves for both cases and propeller speed curve for electric drive. Dotted lines, Parsons drive; full lines, electric drive; line 1-2, one generator and two motors connected for 50 poles; line 3-4, one generator and two motors connected for 30 poles; line 5-6, two generators and four motors connected for 30 poles.

and it would be possible to adopt considerably lower propeller speeds, and by so doing to improve the net result without serious increase of weight.

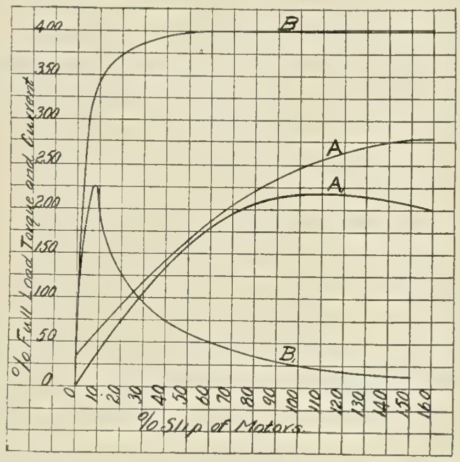


Fig. 3.—Speed, torque and current curves of motors with full frequency and voltage. *AA*—Current and torque with resistance. *BB*—Current and torque without resistance.

Data relating to the operation of this electric drive at different speeds are given in the accompanying tabulation.

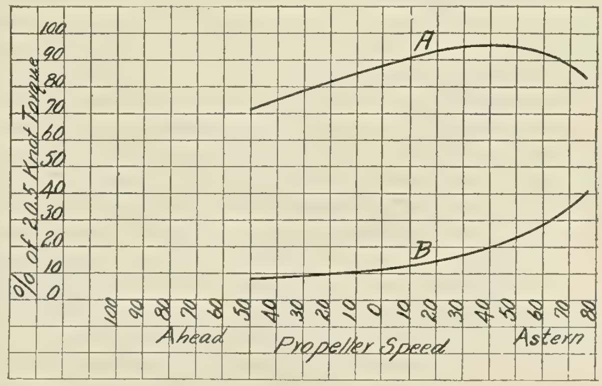


Fig. 4.—Torque and current curves of motor as used, with resistance inserted, in reversing ship. These curves assume normal frequency and reduced voltage. In practice, both frequency and voltage might be reduced, which condition would give better torque. Speed is given in percent of full frequency. Ahead means against generator; astern, with generator.

Reversal.—The characteristics of the motors used in reversal of the propellers are shown by curves, Figs. 3 and 4. Fig. 3 shows the torque and current of such a motor under different speed conditions with full impressed voltage and frequency, two of the curves applying to the condition without resistance in the armature and the others applying to the condition with resistance in the armature. Fig. 4 shows the torque obtainable with such a motor with and without resistances when supplied with the normal full-load current of one generator at normal frequency. These motors would be capable of receiving for a short time even more current than this, but the torque here shown is far more than that provided by the ordinary reversing machinery for turbine ships. Curve *B* in Fig. 4 shows the relatively weak torque obtainable without resistance in the motor armatures. The results shown by this curve can be obtained from any of the motors; those on curve *A* can only be obtained from the motors which are arranged for the insertion of armature resistance. The armature resistances proposed would be connected to the motor through collector rings, and the resistance would be cut out by short circuiting the collector rings, so that no current would pass through brushes except when the resistance was in use. A form of resistance has been developed by experiment by which a very large power can be dissipated in a small space without complication or difficulty, and this with all other details has been included in weight estimates.

Weights.—The weight of the Parsons turbines alone proposed for these ships, as designed and estimated by the Navy Department, is given as 484.7 tons, which weight does not include any piping, bearings, shafting, valves or auxiliaries. The following figures show weights of equivalent parts with the combination drive and electric drive as here designed.

COMBINATION DRIVE.	Pounds.
Two generators	125,000
Two turbines	154,800
Two motors with pole-changing switches	140,000
Switches, etc.	2,000
Additional ventilating ducts	5,000
Two low-pressure turbines	740,000
Total	1,166,800
Equals	520 tons

ELECTRIC DRIVE.	Pounds.
Two motors with pole-changing switches	142,000
Two motors (M)	134,000
Switches, levers, supports, etc.	6,000
Cables, busses, supports, etc.	4,000
Rheostats	3,000
Two generators	280,000
Two turbines, without bearings	218,000
Additional ventilating ducts	7,000
Total	794,000
Equals	354 tons

From this it will be seen that, considering these parts alone, the combination drive would be 35 tons heavier than the Parsons equipment mentioned, and the electric drive would be 131 tons lighter. In the comparison of steaming distances which is here made, this difference alone is considered, but a consideration of the designs will show that other large economies in weight would be effected with the electric drive. The piping system necessary with the Parsons turbine equipment is very complicated, and the weight of steam and exhaust piping and valves given in the department's estimates amounts to 76.5 tons. With this electric drive only one steam pipe connection is necessary inside of the engine room. From this it will be apparent that there is a great saving of piping weight and complication in the electric drive as compared with the Parsons equipment. The writer has no means of knowing the necessary weight of piping outside of the engine room, but it is believed that saving in the engine room would amount to at least 40 tons.

The weight of boilers proposed for these ships is 555 tons, and if with the electric drive the boiler equipment was cut down in proportion to the saving in steam consumption at 20.5 knots, as indicated by the comparisons given above, a further saving in weight of about 108 tons would be effected. This estimate assumes that uses of steam outside of the prime movers are the same in both cases and in accordance with the department's estimates.

TABLE 3.

	Pounds Coal Available.	Water Rate.	Shaft Horsepower.	Distance in Knots at 12-Knot Speed.
Parsons	5,550,000	25.6	4,700	4,700
Electric	6,080,000	17.8	4,400	7,900

Cruising Distance.—The hull plans of these ships, as designed for Parsons turbines, show a bunker capacity of 2,476 tons, or 5,550,000 pounds. Adding coal in place of weight diminutions above mentioned, the total would become 6,080,000 pounds. If we assume 8.5 pounds of water evaporated per pound of coal, and the propeller, steam and electrical efficiencies above indicated, we have the comparison shown in Table 3.

If the same boiler equipment is retained for both systems the comparison will be as follows:

TABLE 4.

	Pounds Coal Available.	Distance at 12-Knot Speed.	Speeds with Equal Steam Flow.
Parsons	5,550,000	4,700	20.5
Electric	5,838,000	7,600	21.2

These figures assume that in both ships the steam consumption for all uses outside the main prime movers at 12 knots is 26,300 pounds per hour, this being the figure given in the Parsons guarantees.

It may be claimed that the Parsons turbine would do better than here assumed, the figures taken being guarantees which presumably afford some latitude for error. Comparison with other cases, however, does not indicate that the water rates assigned to this Parsons turbine are much too high. In the case of the *Lusitania,* where the high speed and large power afford ideal conditions for turbine drive, the water rate shown by tests at maximum speed was 12.77 pounds per shaft horsepower in the turbines alone with 28 inches vacuum, and with 27 inches vacuum it would presumably have been 13.5 pounds. A corresponding water rate shown by the Parsons curves here given, which form the basis of this comparison, is 13.75 pounds, with a horsepower output considerably less than half.

These figures show an increase of 69 percent in the cruising distance, and it is needless to comment upon the immense value of such a difference in any war vessel.

In this comparison it should be remembered that the performances of the electric equipment are very conservatively estimated, and that water rates and efficiencies on existing apparatus would justify the expectations of better performances. It should also be remembered that differences in weight of piping are not considered in this comparison, and also that there should be a large saving in weight of bearings and supporting structures if the electrical equipment is compared with the Parsons turbines. It should further be considered that the propeller speeds here adopted are not those most favorable to electric drive, they having been assumed for the sake of direct comparison with existing designs for the same ships. The electric drive would give almost the same efficiency with lower-speed motors, and the weight would be only slightly increased, while a very large improvement in propeller efficiency could be effected. To get the best results from such a new

method, the whole ship should be designed to suit it, while in the designs here given it is simply made so that it could be substituted for the proposed combination drive without any change except in the propelling machinery itself.

Evidences.—The practicability of the plan of electric drive here proposed cannot be questioned, and the figures given must result from the expected efficiency in generating units and motors. The motor efficiencies given agree with common practice with apparatus of similar capacities and speeds and cannot be questioned. The practicability of the generator efficiency proposed can be proved by comparison with actual test results on a generating unit rated 3,000 kilowatts, of which many are in use, and which have been repeatedly investigated with the greatest thoroughness. In almost all turbine units increase of capacity is decidedly advantageous to economy, and such advantage would exist in this case, although the efficiencies assumed are not superior to those shown by these actual test results.

Advantages.—In this plan for electric propulsion the electrical apparatus simply serves as a speed-reducing bond between the turbine and the propellers, and it may be asked why electricity should be used when the practicability of other methods of speed reduction have been asserted, and to some extent verified, by experiments.

The answers to this are:

First. Electricity is capable of efficiently effecting reduction in a very large ratio, the reduction in this case being in the ratio of 50 : 6.

Second. That the electric speed reduction is susceptible to change of ratio, which makes possible efficient action at different speeds.

Third. The electric speed change involves no kind of complication, difficulty or uncertainty.

The efficiency of this electrical bond will be about 92 percent at all speeds, and this will remain constant through the life of the apparatus. It is questionable whether any other practicable form of speed reduction in such a ratio can be made equally efficient when all friction losses are considered, even if it should be proved that other methods are practicable at all for use in such large ships. The particular type of turbine proposed in this case affords the great advantage of good efficiencies throughout wide ranges of load and speed, which characteristics in combination with the pole changing in motors are of great value in such a case.

The possibilities outlined in this paper, if true, are certainly of great importance to the shipbuilding industry, since they open a field which is almost entirely new. The most important existing electric drive installations of which the writer has knowledge are those of two fireboats in the city of Chicago which were equipped under his direction. While these contain small and relatively inefficient turbines and electrical apparatus, their performance from the first has been efficient, simple and entirely free from trouble. While the present paper relates alone to the propulsion of certain battleships, the figures and facts which it presents are fairly illustrative of a wide range of possibilities in the propulsion of vessels; and while other cases have not been specifically investigated, it is thought that there are a very large number in which electric drive would be better, simpler and cheaper than anything heretofore produced.

NEW SWEDISH AND DANISH SUBMERSIBLES.

BY ROBERT G. SKERRETT.

Fig. 1 shows the *Hvalen* during her official trials at Spezia preliminary to her acceptance and the long run to Stockholm. She is of 230 tons submerged displacement, and is propelled by three screws. During her trials she developed a maximum surface speed of 15.2 knots—her Fiat motors producing 1,050 horsepower. Submerged, the boat makes 7 knots.

The Swedish authorities have become seriously convinced that submarine vessels promise a very effective defnse for the seaboard and the principal waterways of the kingdom, and the building of the *Hvalen* is the first step in the execution of a programme which calls for an extensive flotilla of this order of fighting craft. This is not the first effort that Sweden has made in this direction. It was due to native enterprise that the Nordenfeldt submarines first gained recognition and gave promise of practically solving the difficulties of submarine navigation in the "eighties," but it was not until the advent of the Holland boat that the Swedish admiralty gave any substantial encouragement to the art, when it built the *Hajen*, a virtual reproduction of the *Adder* class of the United States navy.

In 1907, however, the Ministry of Marine, after much painstaking investigation and deliberation, invited proposals from the principal commercial builders of under-water craft. In the competition which followed, designs were offered by Vickers Sons & Maxim, of England; Laubeuf, of France; Krupp, of Germany; Lake, of America, and Laurenti, of the Fiat-San Giorgio, of Italy. The choice fell to the Italian boat, and the *Hvalen* is the consequence.

One of the contract conditions was that the *Hvalen* should

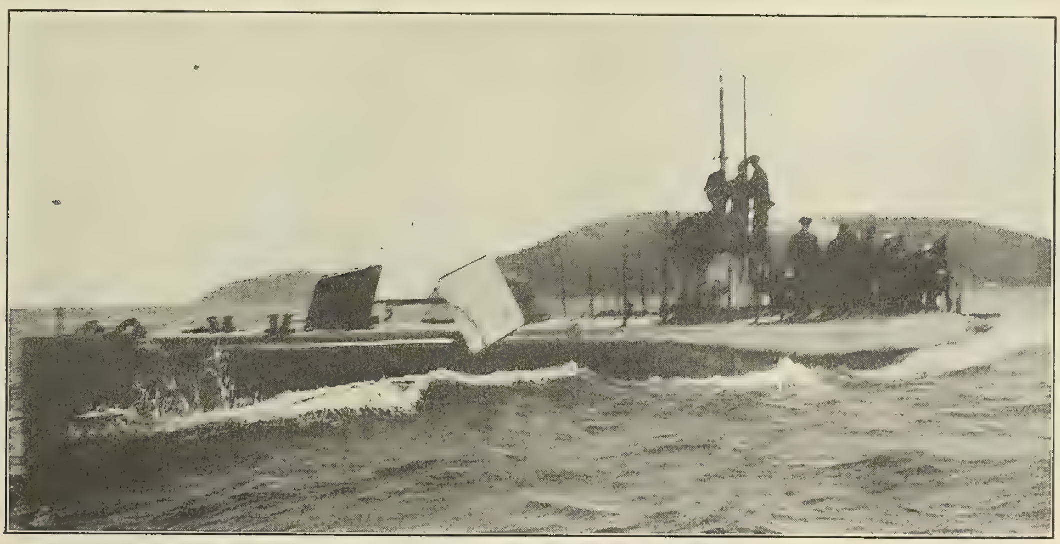


FIG. 1.—THE HVALEN UNDERGOING HER OFFICIAL TRIALS AT SPEZIA.

demonstrate her sea-keeping qualities by making the extraordinary run of 4,000 nautical miles from Spezia, Italy, to Stockholm, Sweden. She was obliged to be self-sustaining, and to cover the distance absolutely unattended by either an escort or mother ship.

The first leg of the journey was from Spezia to Cartagena, Spain, a distance of 790 nautical miles. The boat made this run under her single central screw, and covered the distance in seventy-two hours, an average speed of 10.97 knots, the two wing screws being disconnected and allowed to revolve freely. During this run the boat met with heavy weather, and yet she went on without halt. Her commanding officer, a lieutenant in the Swedish navy, reports that the boat showed remarkable seaworthiness, and the crew arrived at Cartagena in excellent condition.

From Cartagena the *Hvalen* went to Gibraltar, and from Gibraltar to Lisbon. During the run to Lisbon the boat used her twin screws while working her way in the teeth of a regular easterly gale, and, notwithstanding the blow, made an average speed of 11.5 knots. This is a striking performance when we recognize that the best American submarines have made but 11 knots over a measured-mile course and under very favorable weather conditions. The other stages of the run were as follows: From Lisbon to Vigo, from Vigo to Ferrol, from Ferrol to Brest, from Brest to Portsmouth, from Portsmouth to Kiel, and from Kiel to Stockholm.

The principal dimensions of the *Hvalen* are:

Length over all	140 feet.
Beam, maximum	14 feet.
Displacement, when fully submerged	230 tons.
Displacement, light	186 tons.
Number of screws	3
Number of screws used when submerged	2
Maximum brake-horsepower	1,050
Maximum surface speed	15.2 knots.
Radius of action at full speed	480 nautical miles.
Radius of action at 10-knot cruising speed	1,000 nautical miles.
Maximum submerged speed	7 knots.

The boat has a reserve buoyancy normally on the surface of 24 percent of her light displacement, and by a special arrangement of the superstructure it is possible to increase this to 60 percent, thus giving the vessels of the *Laurenti* type a surface reserve of buoyancy fully as great as that of the ordinary above-water torpedo boat. Because of the special features used in connection with this superstructure, this unusual reserve buoyancy does not add any impediment to the rapid submergence of the boat or her emergence and return to the light cruising condition from an under-water run. The superstructure fills automatically when submerging, and is self-bailing when emerging, so there is no occasion for the installation of heavy pumps or the use of any power to control this mass of water

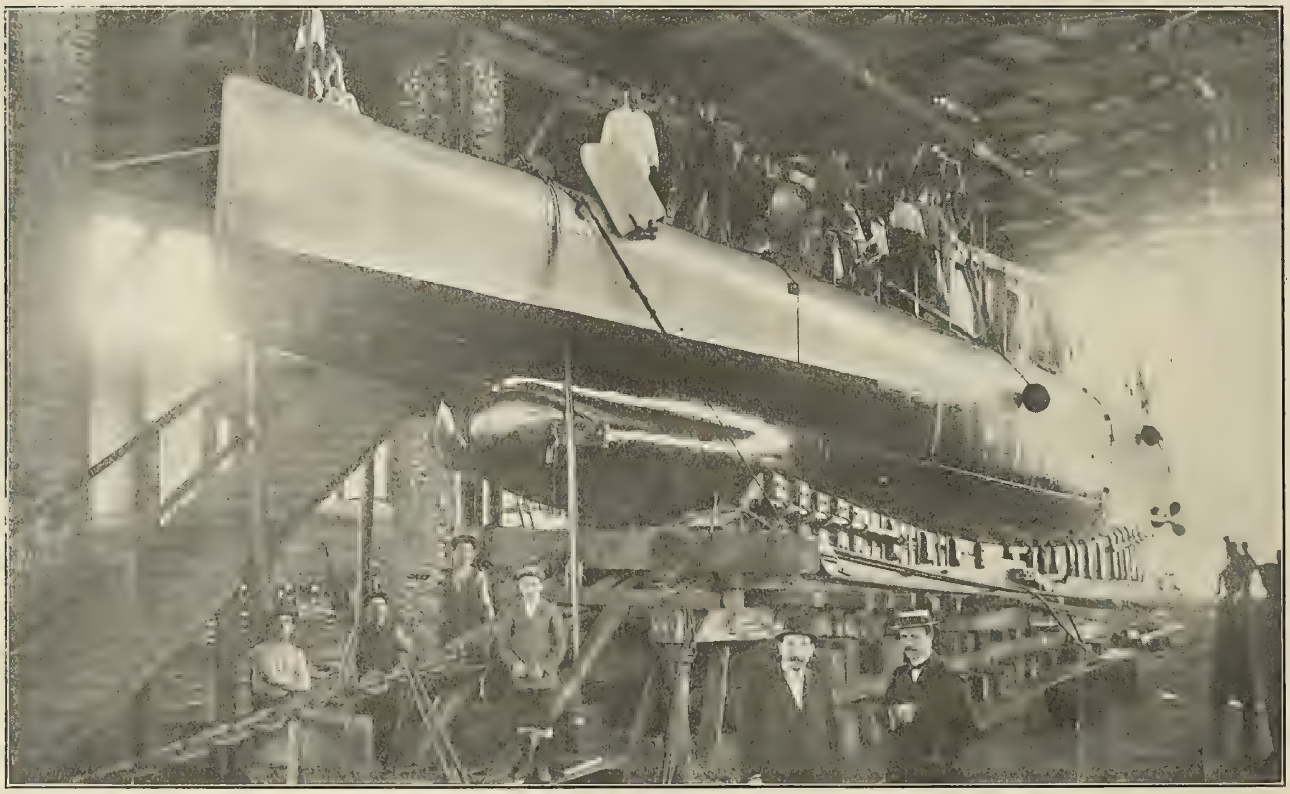


FIG. 2.—DANISH SUBMERSIBLE DYKKEREN.

In America, interest naturally centers in this boat, because an enlarged edition of the type is now building at the yards of Messrs. William Cramp & Sons Company for the United States navy.

The Danish Government, like its neighbor, has embarked upon a programme of submarine construction, and has built a small submersible of the *Laurenti* type. This boat is named *Dykkeren,* and has a modest submerged displacement of 128 tons; in this particular being a virtual counterpart of the American submarines of the *Moccasin* class. The building of the *Dykkeren* constitutes a record performance. The keel of the boat was laid on Sept. 9, 1908, she was launched on July 18, 1909, and finished her final delivery trials Aug. 20, 1909. The *Dykkeren* is entirely electrically propelled, and was designed to meet special conditions prescribed by the Danish Admiralty. Any one studying the coastline of Denmark will readily appreciate that for purely defensive work a submarine vessel need not have a great radius of action.

PERFORMANCE OF DANISH SUBMERSIBLE DYKKEREN.

	Contract Requirements.	Actual Performance.
Maximum surface speed, knots......	11.0	12.02
Cruising speed, knots...............	7.0	8.1
Submerged speed, knots............	7.25	7.5
Radius of action at full speed, nautical miles	18.5	24.0

The time required to pass from complete buoyancy to complete submergence is something less than five minutes, and to return to the surface and be under way at cruising speed requires only three minutes. The soundness of the hull was demonstrated by subjecting the boat to hydrostatic pressure at a depth of 145 feet, when there was no sign of deformation.

The *Dykkeren* is 113 feet 8 inches long, and has a maximum beam of nearly 11 feet. On the surface her displacement is 103 tons, and when submerged 128 tons. The photograph of this boat is of interest because of the installation of the two bow-torpedo tubes. As one can see, these tubes lie well below the waterline and back from the stem of the vessel. Apart from the protection thus afforded to the tubes in case of a bow-on collision, their position insures an equalizing of lateral pressures at the instant the torpedo is discharged, so there is less danger of deflection due to these causes and a minimum of risk of wrenching the tail of the torpedo before it is clear of the tube. Another feature of interest shown by this photograph is the housing of the submerging rudders, so as to get them out of the way of the sea when running on the surface. Where these rudders extend rigidly outboard from the sides of the vessel they are liable to damage when coming alongside a dock or to be strained and bent by the pounding of a seaway.

THE MARINE STEAM ENGINE INDICATOR—V.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

The American Thompson instrument, as made by the American Steam Gauge & Valve Manufacturing Company, is shown in Fig. 36. This is a good example of the modern instrument with an outside spring. The pencil mechanism is practically the same as that shown in Fig. 28, and has the shortened front link. The detent motion is of a type peculiar to this make of instrument. By means of the lever, whose handle is just above the 1899 patent date, the drum and its base-ring may be thrown out of gear. By this means the drum is made stationary at will, for the inspection or changing of cards, while the cord remains taut and in motion with the engine as usual.

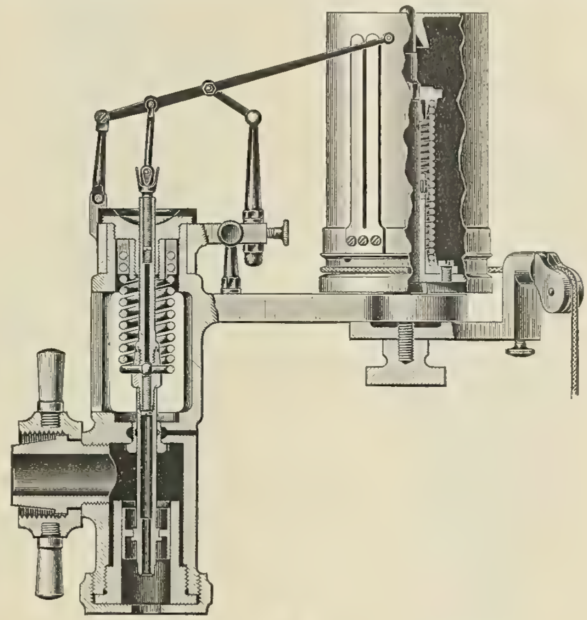


FIG. 37.

Another form of instrument with the shortened front link is shown in Fig. 37. This is one of the many patterns made by the Star Brass Manufacturing Company, of Boston, Mass. It differs from most other instruments, in that it takes steam above instead of below the piston, and its piston area is but ¼ of a square inch. By means of this smaller piston lighter springs are used, and the weight of the reciprocating

* Copyright, 1909, by Charles S. Root.

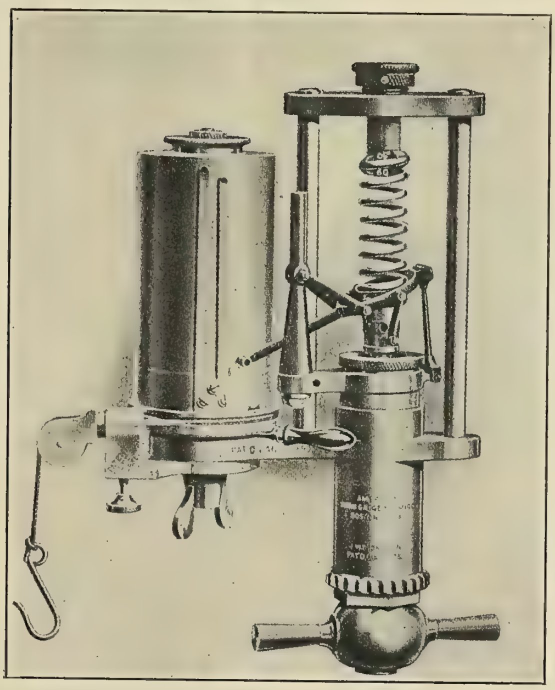


FIG. 36.

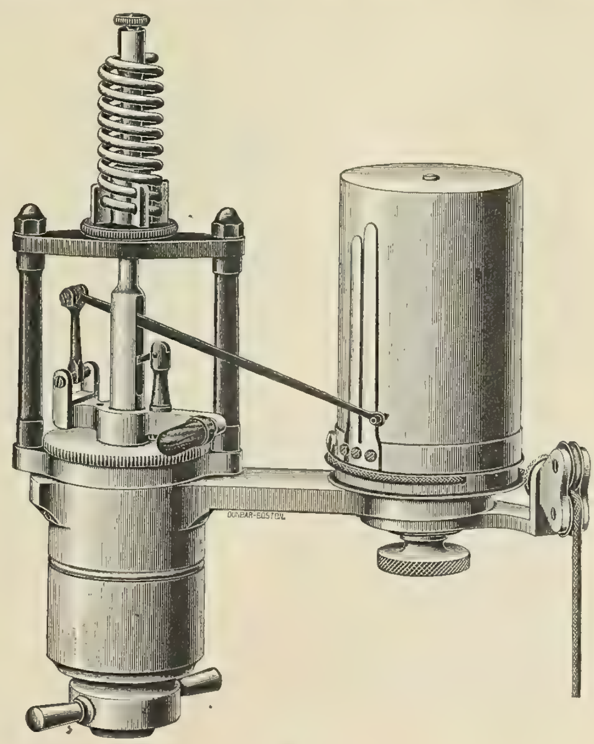


FIG. 38.

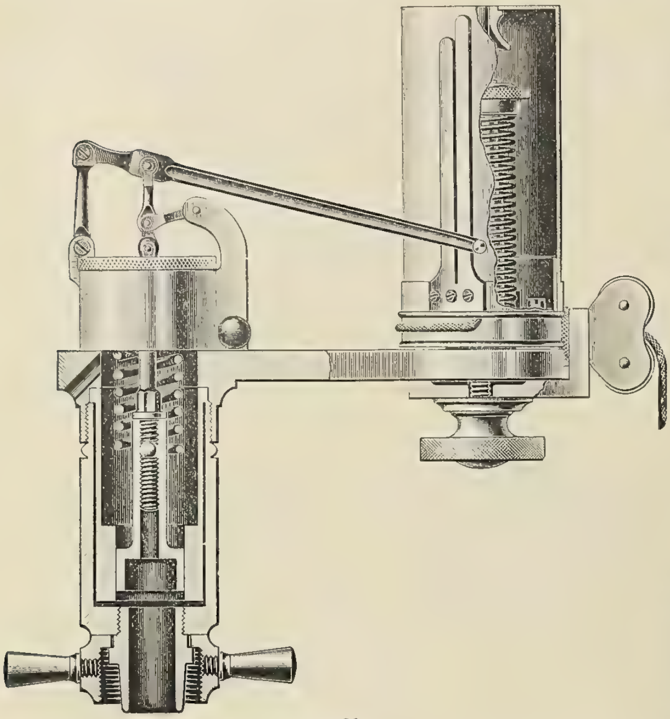


FIG. 39.

parts is no greater than in the same make of instrument with an inside spring and a ½-inch area piston.

In Fig. 38 is exhibited the Crosby indicator, with outside spring. The pencil mechanism of this instrument has its front link attached to the piston-rod connecting link, and has a steam piston of 1 square inch in area, made in the form of the central zone of a sphere. Fig. 39 shows an instrument of the same make, suitable for use either as a steam or gas engine indicator. It is furnished with one piston of ½ inch area for use with steam engines, and another piston of ¼ inch area for gas engines.

A Crosby instrument, as made for ordinance and hydraulic work, is shown in Fig. 40. The pencil mechanism has a post, bearing lightly against the pencil arm, to keep the scriber in contact with the card during sudden shocks. The lower piston, or, more properly, the plunger, is of very small area, and is fitted in a bored hole in the union casting at the bottom of the instrument. When moderate pressures are to be indicated the by-pass valve at the left is opened and the main piston comes into play.

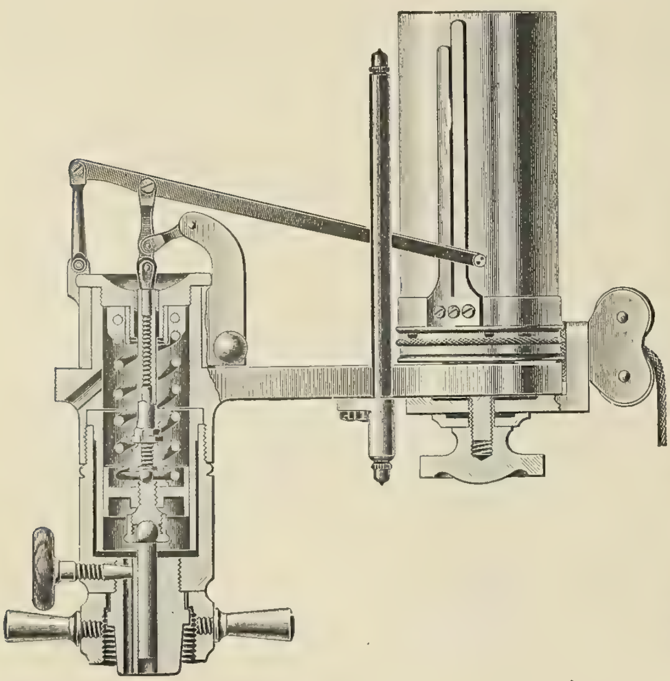


FIG. 40.

In the Tabor instrument, fitted with an outside spring and an electrical attachment for rotating the swivel head, the pencil motion is rectified by a sliding pair, whose path is curved, as shown in detail in Fig. 41. The instrument, as

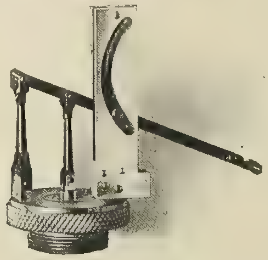


FIG. 41.

shown, is the product of the Ashcroft Manufacturing Company. The flat spring indicator of Batchelder is shown in Fig. 42. The spring is at *B*, and its "scale" is altered by shifting the slide and fulcrum *S* to the right or left. The pencil is guided by a straight slide, as shown in Fig. 30.

Many other forms of indicator, additional to those described here, have been designed and made, but only one other kind will be noticed.

For extremely high speeds, the ordinary indicator will not answer, owing to the disturbing effects of inertia. Some years ago Mr. Carpentier, of Paris, France, designed an instrument which he called a Manographie. He arranged a small mirror so that it was deflected in one direction by changes in cylinder

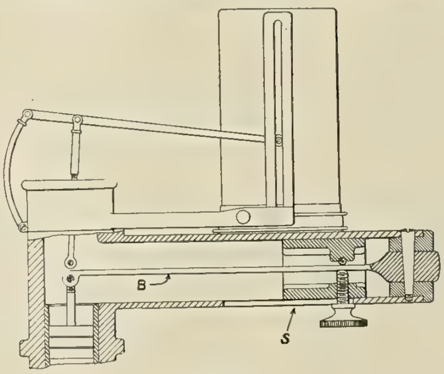


FIG. 42.

pressure, and in a direction at right angles by the movement of the engine cross-head. A lamp was so located that a beam of light thrown on the mirror was reflected in a point on a ground-glass screen or photographic plate, and a momentary view or a permanent record of the diagram was obtained. This apparatus was successfully used on gas engines running at speeds of 2,000 revolutions per minute.

In concluding this section, the attention of the reader is called to the fact that most indicator manufacturers are in a position to furnish instruments with large or small pistons, inside or outside springs, large or small drums or those fitted for continuous cards, instruments with but one size of piston or the combination of large and small cylinders, and, lastly, instruments entirely steel fitted for use on ammonia compressors. The user is thus free to choose the instrument whose general design most nearly satisfies his idea of what an indicator should be.

For high-speed work lightness of the moving parts must be the prime consideration, but for moderate or slow speeds this

may be sacrificed for other advantages which the purchaser may desire. Consideration should also be given to the ease with which springs may be changed, lost motion taken up and the instruments changed from right to left hand.

S. S. MONITORIA IMMEDIATELY AFTER LAUNCHING, SHOWING EXTENT OF CORRUGATIONS.

THE MONITORIA.

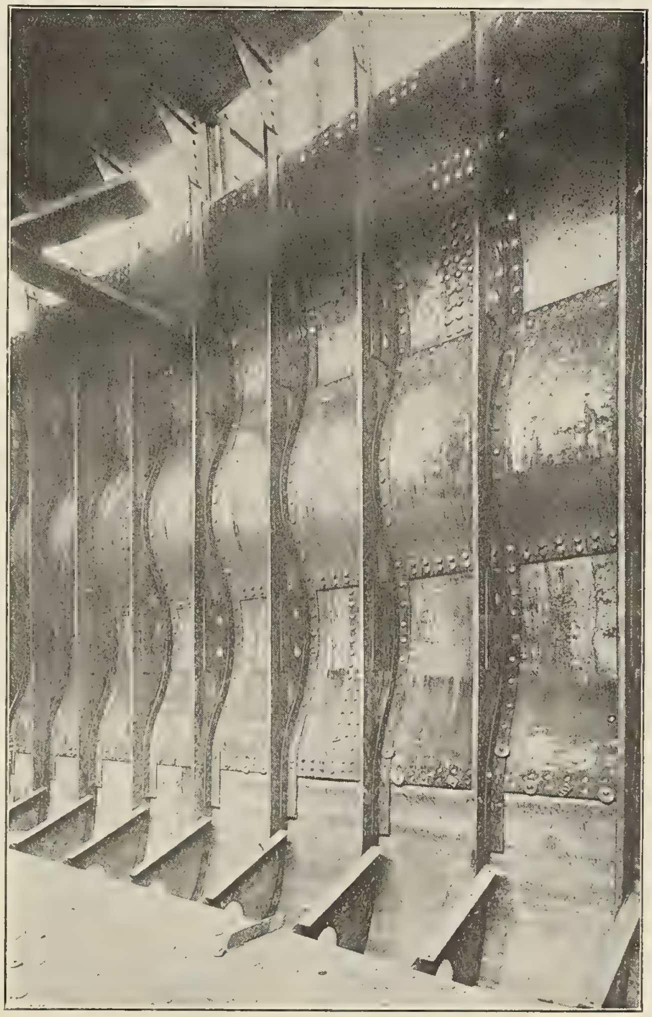
BY ARTHUR H. HAVER.

The latest improvement in the construction of ships consists in an application to the outside form. This part of the ship has hitherto been carefully ignored by the majority of ship designers, as it has evidently been concluded that the ordinary ship form did not admit of any radical improvement in reducing resistance. It is, therefore, more than usually interesting to know that the *Monitoria,* an ordinary cargo steamer, 279 feet 6 inches long, 39 feet 10½ inches breadth, molded, and 20 feet 7½ inches depth, molded, of unusual form, has proved to possess remarkable advantages, which indicate that a law hitherto ignored has been applied which enhances the value and improves the speed of ships, or what is the same thing, reduces the horsepower and coal consumption of all classes of vessels.

Instead of the usual wall-sided shell plating, this vessel has been designed with two longitudinal projections along the outside of the ship between the load waterline and the bilge, in the form of sections of rather flat arcs, so that the breadth of the ship becomes nearly 42 feet extreme, or about 22 inches wider than the molded breadth. These corrugations do not extend to the extreme ends of the vessel, but stop where the hull begins to fine forward and aft. Naturally, these projections give more buoyancy and add to the displacement of the vessel; they also increase the wetted surface and increase the periphery of the shell plating girths. Although these conditions must be considered as prejudicial to speed, nevertheless in this ship greater speed was proved to exist, both by numerous tank experiments extending over nearly four years and by results on the measured mile and on ocean voyages.

The improvement of 5 percent in speed at 10 knots disclosed by the tank experiments was realized on the actual ship, while at 9 knots instead of the 4.16 percent greater speed anticipated the actual increase proved to be 4.23 percent.

This vessel is owned by the Ericsson Shipping Company, of Newcastle-on-Tyne, and was built by Messrs. Osbourne, Grahame & Company, of Hylton, Sunderland. This firm has made a specialty of a type of vessel of the ordinary three-island construction, to carry 3,200 tons dead weight, cargo and bunkers, and the special form, tonnage, speed and power of these vessels have proved so economical that twenty-three vessels have been built from the same design practically without alteration. Owners of these vessels have expressed themselves satisfied with their good performance, one remarking that if anyone could improve the earning power of his ship it must be a noteworthy achievement. This type of vessel was therefore chosen as the one on which to try these longitudinal projections, principally from the fact that it was a successful design, and not one remarkable for inefficiency.



DETAILS OF CONSTRUCTION OF THE CORRUGATED HULL.

The trial under ballast conditions, with the corrugations above the ballast waterline, proved that the *Monitoria* was no different from any of the sister ships, the same speed and power being obtained. The loaded trial, however, showed that when the corrugations were immersed, practically the same speed was attained as when light, although at this draft she carried about 135 tons more displacement than her sister vessels in loaded condition, and with the same engines, indicated horsepower and propeller the speed was three-eighths

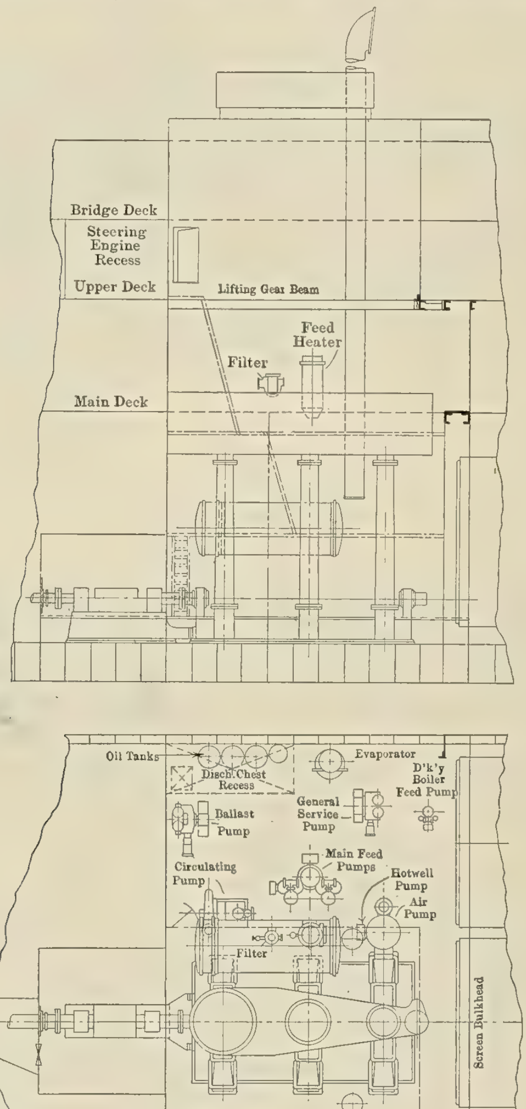


FIG. 10.

of a knot more than that of her sister ships, which means that at the same speed as her sister ships she was capable of being propelled with 14 percent less power.

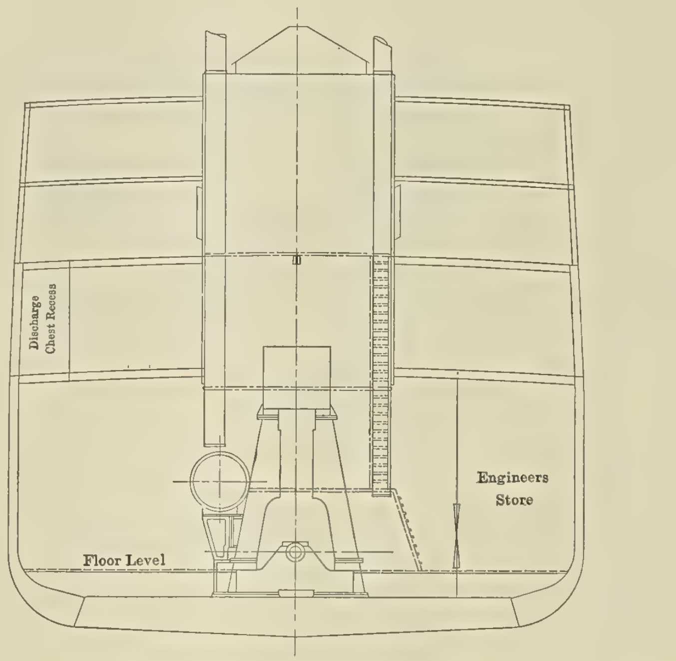
The engines have cylinders 21, 33, 56 inches by 36 inches stroke; there are two boilers, operating at 180 pounds pressure, with a heating surface of 3,000 square feet.

In the following table two of the sister ships are marked A and B; the *Monitoria* was run on the measured mile, progressively. The results, compared with vessels A and B, are as follows:

	A.	B.	Monitoria			
Trial displacement....	4,440	4,450	4,575	4,575	4,575	4,575
Knots speed	9.76	9.78	9.68	9.78	9.96	10.12
Indicated horsepower..	1,133	1,116	966	1,000	1,120	1,195
Revolutions	70½	70	65½	66¼	68¼	69¼
Draft	17.8	17.8½	18.0	18.0	18.0	18.0
Steam pressure	180	180	175	175	175	175

Propeller slip from 3 percent to 6 percent.

A noticeable feature was the steadiness of the *Monitoria's* motion through the water. There was no vibration, and no broken water was to be seen leaping up and running freely



Engine Room, Looking Forward

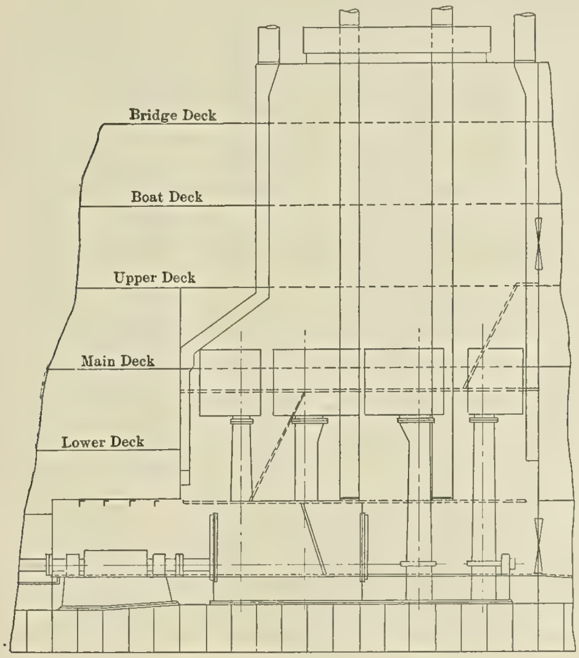
along the sides; but, instead, a smooth, subdued, undulating wave line about 3 feet wide took its place, perfectly clear and transparent, so that the projections on the hull 10 feet below were quite easily discernible. The usual foam-covered surface, caused by the broken head wave, was carried about 3 feet clear of the ship's side and parallel to it, showing that a most noteworthy subduing action of the stream-line waves was operating for the ship's benefit. The increased speed (or it can be expressed as a reduction of horsepower) appears to have been attained by robbing a portion of the power usually expended in creating the amplitude or height of the waves and at the same time increasing the wave length due to the restricted amplitude. The power saved in this vertical restriction of wave becomes available for horizontal propulsion. The increased length of wave gives a greater speed of wave, which reduces the friction power, eddy formation and bow wave, besides assisting all other stream lines around the ship.

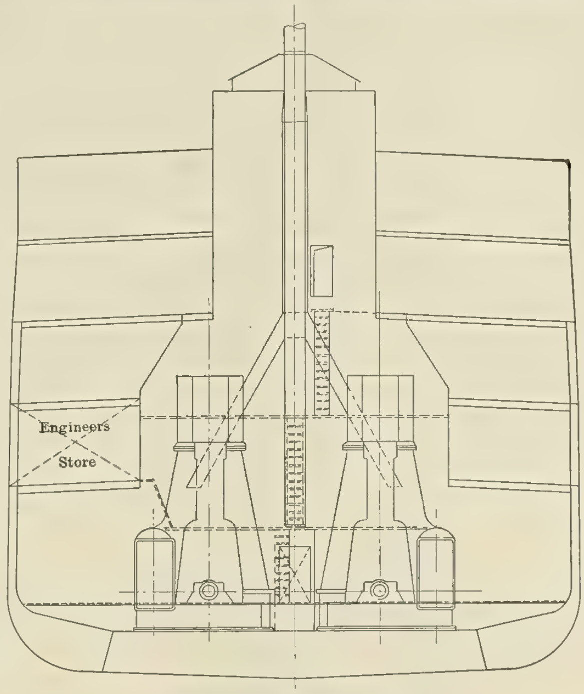
Naturally, as there is a greater frictional area, due to the greater periphery of the shell, there must be more frictional resistance. The amount of power to be allotted to this frictional resistance may be open to doubt, and many text books could be proved to be wrong in the amount they allot to it, but whatever the amount lost by the increase of wetted surface, due to the corrugations, there is no doubt whatever that more power is available, not only to overcome this increase of wetted area but also additional power for the propulsion of the ship.

In the type of vessel, of which the *Monitoria* is the first, we have a vessel which actually accomplishes the hitherto impossible task of carrying 3 percent more cargo in a hull having over 3 percent more displacement, yet doing it at her commercial speed with over 14 percent less indicated horsepower.

The size, proportions and position of these corrugations must be decided upon to suit the form, fineness, speed and size of the vessel. Varying proportions give varying results. Full ships give greater percentages of improvement than very fine ones. In respect to rolling, the corrugations act in the same manner as a bilge keel, causing the ship to have a slower period of roll besides effecting a reduction in the amplitude of the roll. This also occurs longitudinally by crushing the end waves which would tend to rise on deck. These points make for a better sea boat, fewer shocks, greater steadiness and greater strength. The action of the corrugations in reducing the eddy at the after end causes the oblique stream lines to be more nearly horizontal, giving a better run of water to the propeller and rudder, resulting in better steering and less slip of the propeller. The ship can also make a better passage in a head sea, and has more strength to resist the hogging and sagging strains.

A battleship or cruiser fitted with these corrugations would have a steadier gun platform, a greater range of action, carry more fighting metal, and have a greater speed. A passenger boat would be steadier, stronger and more comfôrtable, be more economical in coal and carry more weight.





Section looking Forward

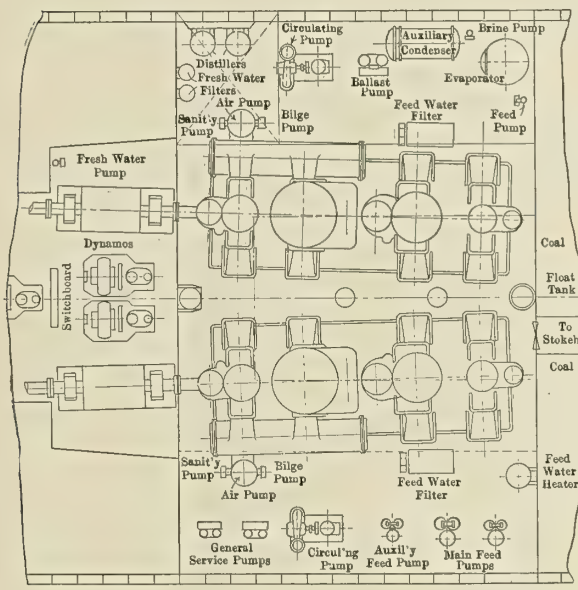


FIG. 11.

MACHINERY AND PIPING ARRANGEMENTS ON BOARD SHIP—II.

BY JOHN M'COLL.

THE ENGINE ROOM.

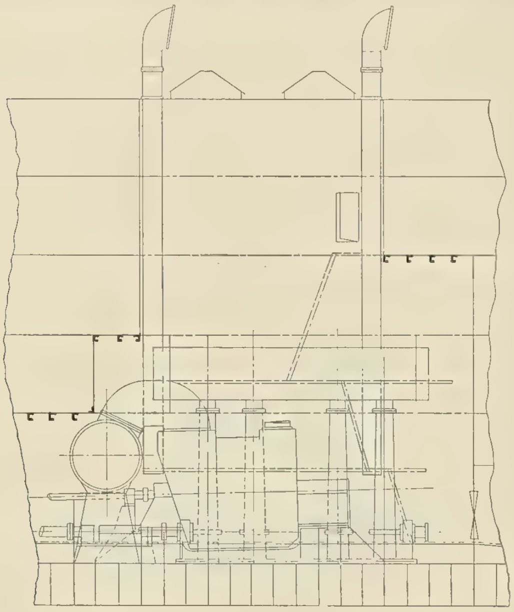
In fixing the position of the main engine for a single-screw vessel, much will depend on whether the shaft is required to be parallel to the base line, or whether it may be raked. It often happens that with an average diameter of propeller, ordinary depth of sole plate, and depth of ship floors, the distance from the base line to shaft center is much less in the engine room than at the stern frame. If the rake of the shaft is small, the aft end of the sole plate is made deeper, to keep the holding-down flange parallel with the tank top. If the shaft must be parallel to the base line, two methods may be adopted to make up the level in the engine room. A complete seat of girders and tie plates may be built on the tank top or the whole tank in way of the engine may be increased in depth. The latter is the better way and is that usually adopted.

It is important that the holding-down bolts should, if possible, pass through the floor angles, in addition to the tank-top plating. This can be arranged by fitting broad angles at the top of the floors, or broader flanges at the bottom of the sole plate, or, inclining the floor at the top, forward or aft, as the case requires. A tracing of the bottom of the sole plate should be made and laid on top of the tank-plating drawing; this moved forward or aft from the approximate position will enable a compromise to be readily made.

The thickness of the tank-top plate under the main engines is increased to from ¾ inch to 1 inch thick; and care should be taken that the fore-and-aft laps do not hinder the proper fitting of chocks all round. The thickness of chocks should not exceed 2 inches, and each holding-down bolt should pass through a cast iron chock.

Assuming, in the first case, that the shaft is not to be raked, and the position of the boilers has been fixed, the arrangement may be as that shown in Fig. 10. At the forward end suffi-

cient space must be allowed for a passage from side to side. If the high-pressure valve is at the forward end of the cylinders, then the eccentrics at the floor level, and quadrants and wiper shaft lever higher up, must be considered. A guard will be required around the eccentrics; and the boiler mountings on the back of boilers, especially in jobs with three boilers abreast, may project into the apparent clear space and block the passage. At the aft end it is advisable to provide a passage across the engine room, and this is usually done by



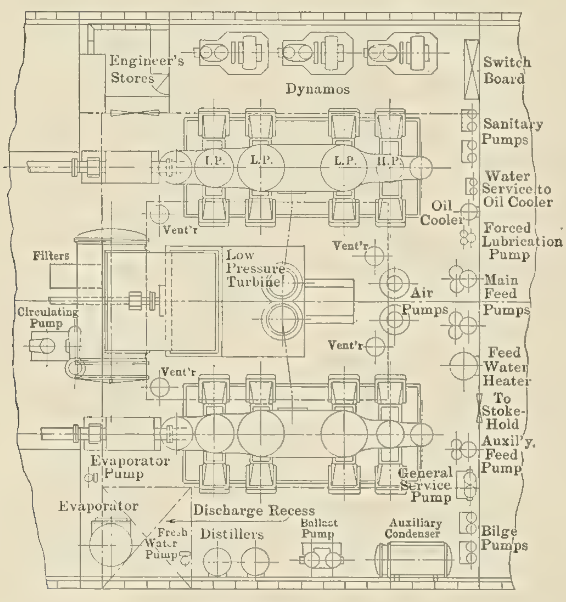
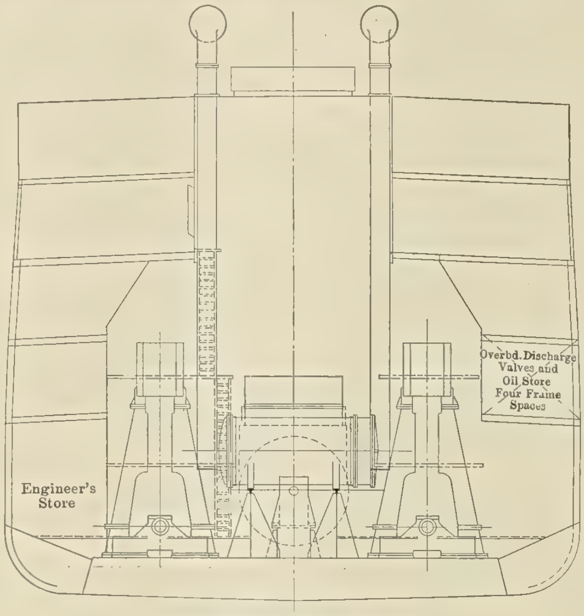


FIG. 12.

placing a bridge over the shaft between the sole plate and thrust block.

If for any reason the condenser tubes cannot be withdrawn from the forward end, provision must be made for that purpose at the aft end. Two methods may be used to meet this requirement. A hole in line with the condenser may be cut in the aft bulkhead and fitted with a portable plate, or the thrust block recess may be made wide enough to suit, as shown in Fig. 11. In the former case it may not be convenient when required to remove the plate and shift whatever cargo may be behind it. In the latter case there need be no delay, and many uses could be found for the little extra space taken up. In using the portable plate method, the thrust recess side may be so close to the block that it prevents chocks from being properly fitted there; in that case the plates on that side should be left loose till the block is bolted down. On the working side of the thrust block the width of recess is fixed by the width of the watertight door to the tunnel, and, as it is seldom possible to haul a vertical sliding door, space for a horizontal door has to be allowed. The height of the recess need not be more than gives ample head room entering from the engine room.



ENGINE ROOM LOOKING FORW.

The casings in way of cylinders should be wide enough to have a passage all round, more so if the receiver pipes project above the top grating. In fixing the casings above the cylinders, the points to be considered are: the cylinder-cover lifting gear, the entrance ladder or ladders, and the ventilation. In small jobs a rough guide for width of casings is that it should be sufficient to let the sole plate down without having loose work.

Generally there should be as little loose work as possible, and that is again a matter for arrangement between the shipbuilder and the engineer. Should the fitting out take place in a side way, liable to be disturbed by passing traffic, it is obvious that more space for shipping engines and boilers should be allowed than in the case where a ship may lie in a private basin and be free from such disturbing influences. In special cases it will be advisable to consult with the engineer in charge of the fitting out regarding his proposals for shipping the engine and boilers, as he should know best the capacities of his cranes and other appliances. In most cases, and especially in ships of light scantlings, a shell plate low down in way of the engine room should be left off till near the launch for the shipping of shafts, pumps and other gear. If the overboard discharge valves are required to be above the load waterline, space along the ship side will be taken for these and access to the space will also be required. Should the space be conveniently accessible, it is usually fitted up as a store for heavy tackle. If, however, these valves may be below the load waterline, no special provision need be made for them. If asked for early, shell butt straps or laps may be arranged by the shipbuilders, to suit the best positions for the larger valves.

In twin-screw jobs, the distance between engines depends mainly on what is considered a reasonable working space. It varies from 18 inches for small to 46 inches for large engines, measuring at the bottom flanges of the front columns at the forward end. As the types of engines and types of ships vary so much, the distance has to be arranged to suit each case.

Fig. 11 shows an arrangement for a high-class twin-screw steamer where a fair compromise has been arrived at between shipbuilders and engineers regarding the space taken up and simplicity in design of casings. In this connection, while the engineer is upholding his requirements for working room, the shipbuilders' work has to be considered, and the more simple the casings are the better for all concerned. As the work proceeds the engineer should see that he gets early information about all pillars, stiffeners and bracket plates, so that he may keep clear of these with his fittings.

Fig. 12 shows an arrangement for a combination of two reciprocating engines with one low-pressure turbine. The reciprocating engines, as usual, rest on the tank top. The height of the turbine is fixed by the distance between the foot valves of the air pumps and the lowest part of the turbine blading. This distance varies from 16 inches to 26 inches, to insure the efficient draining of the turbine. The position fore and aft may be fixed roughly by keeping the steam inlet on the turbine in line with the exhaust branch on the reciprocating engines. If placed much further forward the engine centers are made wider, and little space is left for a convenient arrangement of auxiliaries in way of the starting platform. If placed further aft, more room is taken up for the condenser. The condenser may be made in two parts, and placed low down between the shafts, with the tubes fore and aft; but if made in one it should ride over the center shaft, close up to the turbine, with the tubes across the ship. The rake of the shafts, both horizontal and vertical, depends in each case on the shape of the stern and the diameter of the propellers.

AUXILIARIES.

A good arrangement of auxiliaries is of great importance, as on that will depend the handiness and simplicity of connections, the accessibility for repairs, the easy working of the engine room generally, and the first cost. They should be grouped in their proper relation and sequence, so that, say, the air pumps, filters (if of the gravitation type), feed pumps and feed-water heater are together, the evaporator, distiller, filters and fresh-water pump are conveniently placed, and the sanitary, ballast and bilge pumps are beside each other. The general service pump is usually placed about the forward end of the engine room, and the ash ejector pump, if in the engine room, should be as near the boiler room as possible. This arrangement of auxiliaries is not always possible; for, although it has become usual to have all auxiliaries independent, many firms still prefer to have at least the air, bilge and sanitary pumps worked off the main engines.

The electric generating machines are sometimes placed in the thrust-block recess, or on a flat at the aft end or at the side of the engine room. In some cases a smaller dynamo is placed high up in the casing, so that should the lower dynamos become flooded, some light may be obtained. If they are required to be in the engine room proper, they should be kept well above the engine-room floor level, and clear of any oil or water that may be thrown out by the main engines; but wherever situated they should always have the axis of the shaft lying fore and aft. It will be an advantage for the engineer in charge of the engine room to see whether all the usual auxiliaries are working correctly or not without leaving the starting platform. This can be done in some cases, and should be considered where convenient. As the refrigerating plant may be placed almost anywhere in a ship, the location of this can only be dealt with according to circumstances.

In designing seats for auxiliaries, consideration should be given to the fact as to whether the engines are fast or slow-running. In the former case, the seats have to be substantially and rigidly built. The top plates are made from $\frac{5}{8}$ inch to $\frac{7}{8}$ inch thick, and the side plates from $\frac{3}{8}$ inch to $\frac{5}{8}$ inch thick. In the latter case the top plates may be $\frac{1}{2}$ inch to $\frac{5}{8}$ inch thick, and the side plates $\frac{3}{8}$ inch thick. Large holes, and as many as possible without weakening the structure, should be made in the side plates; these will facilitate the building, and can be used for passing pipes through if required. Hardwood chocks, 1 inch thick, are fitted under auxiliaries, having large, flat bases; other auxiliaries should be bolted direct to the seat, and if thin chocks are needed these should be of steel. The seats should be so arranged, if possible, that the holding-down bolts pass through the top angles as well as the top plate.

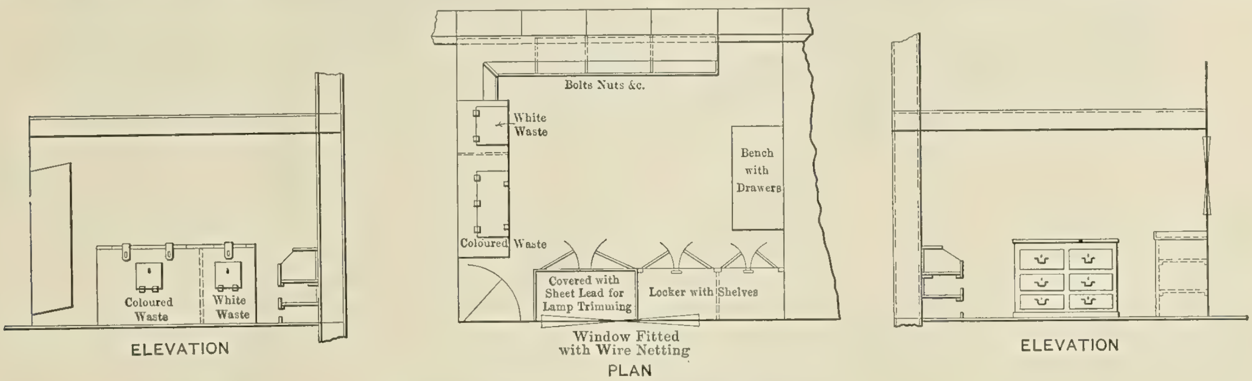


FIG. 13.—ARRANGEMENT OF ENGINEER'S STOREROOM.

The arrangement and size of the engineer's store room vary with the size and class of ship and the duration of voyage. It should be placed, if possible, about the floor level, and be well ventilated. If placed where, to reach it, ladders and gratings are required, these should be made wide, easy and strong, so that a man may carry heavy articles up or down without danger. An arrangement for an ocean-going steamer is shown in Fig. 13. Oil tanks are put in any convenient place about the engine room, usually on a side stringer, if at a suitable height. If the main engine cast iron columns are fitted as engine oil tanks, only small tanks will be required for the special oils, and these could be placed in the store. Round tanks are cheaper, but take up more space than those of rectangular section. The large tanks can be filled from deck with a portable leather hose, but permanent wrought iron piping can be arranged very simply, and is to be preferred.

The engine-room entrance ladders should be not less than 18 inches wide, with cast iron steps, and should have an easy slope. The top grating, in way of the cylinders, ought to be strong enough to bear a considerable weight, so that when overhauling, material may be safely laid there. All engine-room ladders should have cast iron steps, and, if possible, all gratings should have flat-topped spars.

In arranging floor plates, steps and inclines are to be avoided in the main passages, and plates ought not to be too

large for one man to lift easily. Small plates imply more supports than large plates, but that is an advantage, as they are sometimes subjected to heavier burdens than they were expected to bear.

Intricate floor work around auxiliaries is not required, ready access to the fittings is the main end; but hand-rails, in way of the smaller auxiliaries, are sometimes an advantage, and give the engine room a better finished appearance.

THE NEW STEAMSHIP WILHELMINA.

The new steel steamship *Wilhelmina,* now building at the yards of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Matson Navigation Company, of San Francisco, is intended for freight and passenger service between San Francisco and the Hawaiian Islands. She is of the following principal dimensions:

Length over all...............	451 feet.
Length on waterline..........	435 feet.
Beam, molded	54 feet.
Depth, molded to upper deck..	33 feet 6 inches.

The vessel is of the ocean-going type, with raised forecastle and combined bridge and poop, but differs from the general type of ocean-going vessels of similar dimensions and power in having her propelling machinery located in the after end of the vessel. She has the usual type of straight stem and elliptical stern, and is schooner-rigged with three steel pole masts. There are two complete steel decks in the hull, also an orlop deck in the forward hold. The vessel has a complete double bottom and a deep tank amidships, arranged to carry fuel oil or water ballast in all compartments except those under the engines and boilers, which are fitted to carry fresh water for boiler feed, etc. The space between the double bottom and orlop deck in No. 1 hold is also arranged to carry fuel oil or cargo. Above the bridge deck, amidships, are two tiers of steel houses, containing accommodations for passengers and the captain's quarters, and above these in a teak house are located the wheel-house and deck officers' quarters. A flying bridge is fitted at the level of the top of the upper house.

As before stated, the propelling machinery is located in the stern, the boilers and engine being in separate watertight compartments. The six main boilers are arranged with a fore and aft fire-room, all up-takes leading to a common stack. A vertical donkey boiler is located on the main deck level at the after end of the boiler room. Settling tanks for the fuel oil are located on each side of the vessel at the back of the boilers. The dynamo room is on the main deck abreast the engine room on the starboard side, the refrigerating plant on the port side, and the engineer's workshop at the after end.

HULL CONSTRUCTION.

The double bottom is built on the cellular type, with floor plates on each frame, a continuous vertical keel and two intercostal longitudinals on each side. The vertical keel is 60 inches deep throughout, oil-tight in all oil-carrying spaces and watertight elsewhere. All frames are cut at the margin plate, th latter being normal to the frames. Small expansion trunks, extending to the main deck, are fitted to all oil-carrying compartments, and dwarf cofferdams are fitted at all bulkheads enclosing oil spaces. Transverse framing is of the angle and reverse-bar type, with web frames spaced six spaces apart, and with side stringers of plate and angle construction. All deck beams are of channel section, supported by two continuous girders with wide-spaced cylindrical stanchions.

The orlop, main and upper decks are complete steel decks, the main being flush plated for convenience in trucking freight. Partial steel decks are also fitted on the bridge deck and upper bridge, these two latter decks also having complete calked decks of yellow pine with teak margin. Yellow pine calked decks are also laid on the forecastle, on top of all deck houses and in all passenger and crew accommodations on the upper deck.

The vessel is sub-divided into compartments by seven watertight bulkheads, all extending to the upper deck. All bulkheads in the accommodations aft are steel, as are also the machinery casings, which extend from the main deck to a full deck height above the bridge deck.

PASSENGER ACCOMMODATIONS.

Accommodations for first class passengers are all located amidships on the upper deck and in the bridge deck houses, there being forty-eight staterooms, with two berths each, and three special rooms with brass beds. All first class staterooms are fitted with metal berths, mahogany folding lavatories, and with a wide, upholstered transom seat which may also be used for a berth. Two special rooms on the bridge deck are paneled in black walnut, and all other passenger staterooms are paneled in pine, the ceiling in all staterooms being also paneled. The staterooms in the deck houses are all outside rooms, and those under the bridge are arranged generally in sections of four rooms each, with access from alcoves.

The main dining saloon, with a seating capacity for 140 persons, is located at the forward end of the bridge deck, and extends the full width of the vessel. It is paneled in white pine, and furnished with mahogany tables and sideboard and mahogany dining chairs with leather upholstered seats.

A large social hall is located at the forward end of the house on the bridge deck directly over the dining room. It is paneled in mahogany, and all seats are leather upholstered. The main stairways between the different decks in the passenger quarters are mahogany. The first class smoking room, located at the after end of the bridge deck house, is paneled in mahogany and has a beamed ceiling. A buffet is built in at the after end of the room. All upholstery in the smoking room is leather.

The first class toilet rooms are located on the upper deck at the after end of the first class quarters. These rooms are finished in mahogany, and have mosaic tile on the floors and a tiled wainscoting. Three bath-rooms for men and two for women are located in the toilet enclosures. In addition there are six single bath-rooms, four on the bridge deck and two on the upper bridge, access to which is obtained from the open deck and from the adjacent staterooms. All bath-rooms have tiled floors and tiled wainscoting.

The captain's quarters are located in the forward end of the upper bridge deck house, and consist of a stateroom and office, both paneled in mahogany. Direct access to the wheel house above is had by an inside stairway from the captain's office. Rooms for the first and for the second and third officers are located back of the wheel house in a deck house built of teak. The chief engineer has especially large quarters, consisting of a stateroom and separate office, finished in oak, and located aft of the engine hatch on the bridge deck. Quarters and mess rooms for other members of the ship's complement are located abreast of the machinery casings on the upper deck and in the forecastle.

The space on the upper deck between first class quarters and the crew's accommodations is arranged to be used for cargo or for steerage passengers, there being portable metal berths provided for 108 of the latter.

The first class galley is located on the upper deck aft of the first class staterooms, and extends the full width of the vessel. Forward of the galley is the first class pantry, from which access is had to the passages leading to the dining room. All conveniences in use on modern, high-class vessels are fitted, including bake ovens, charcoal broiler, steam vegetable cooker, urns, steam table, egg boilers, etc. A "built-in" refrigerator is located at the forward end of the pantry. The ship's cold-storage rooms and room for stewards' stores are

THE WILHELMINA FITTING OUT AT HER BUILDERS' DOCK.

located on the main deck just forward of the refrigerating plant.

CARGO ARRANGEMENT.

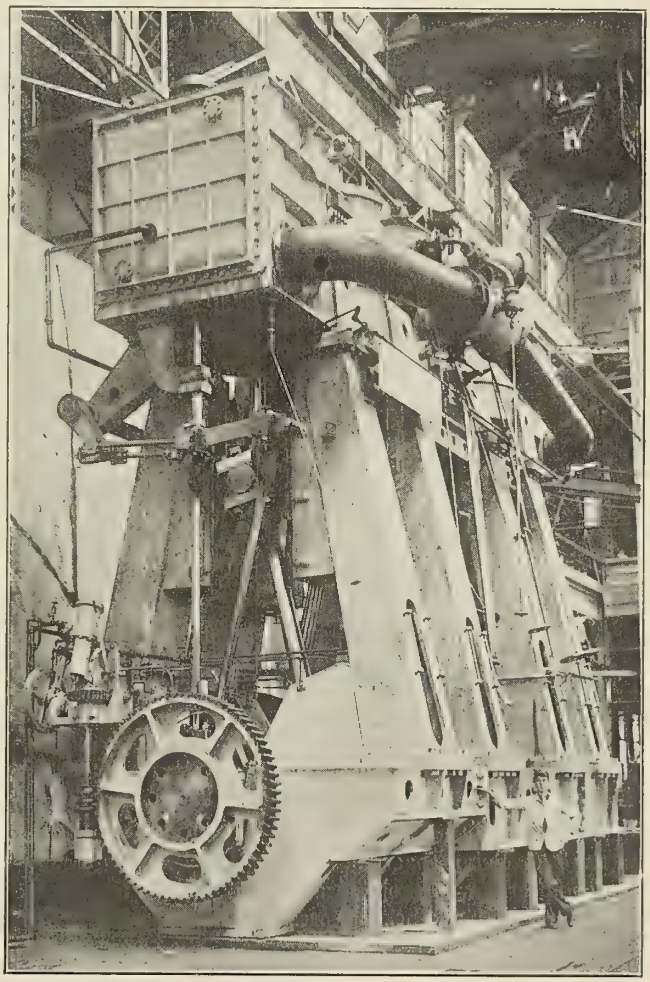
The cargo of the vessel will generally be more or less bulky in nature, and heavy machinery is also carried at times. To suit such conditions large hatches have been fitted and large cargo ports have also been provided, four of these being fitted on each side between the main and upper decks, and one on each side between the upper and bridge deck. All main cargo ports are fitted with watertight sliding doors. All cargo hatches are so arranged that they may be worked by booms attached to tables on the masts. For each of the main hatches there are two booms of 8 tons capacity each. There is also a 50-ton steel boom located on the after side of the foremast, and one 20-ton boom on the after side of the mainmast. An 8-ton boom is fitted on the forward side of the mizzen mast for handling engine-room weights.

For carrying refrigerated cargo, a cold-storage space of 10,450 cubic feet capacity is provided on the main deck amidships. The plant for circulating brine in this space consists of two 8-ton ammonia compression machines, supplied by the Vulcan Iron Works, of San Francisco.

The vessel is lighted throughout by electricity. The generating plant consists of three units of 5, 15 and 30-kilowatt capacity, respectively, all supplied by the General Electric Company. Other electrical items consist of a 7½-horsepower Richmond Electric Company motor for operating the workshop machinery, and a No. 6 Sturtevant blower for ventilating the upper 'tween deck space in No. 1 and No. 2 holds for the carrying of fruit. A 14-inch Rushmore searchlight is located on the top of the pilot house.

For handling the stockless anchors, which are of the Baldt type, there is a Hyde windlass, located on the forecastle deck, the engine for driving the windlass being located on the deck below. The latter engine also drives the capstan, which is located on the forecastle deck aft of the windlass.

The steam winches for handling the cargo consist of eight double 7 by 10-inch winches, supplied by Murray Bros., of San Francisco. There is also a Hyde double 8-inch by 10-inch



MAIN ENGINE OF THE WILHELMINA.

steam winch, located on the poop deck aft, for warping purposes.

The steam steering gear is of the Brown tiller type, supplied by the Hyde Windlass Company. It is operated from the pilot house by a telemotor, and an auxiliary steering stand is also attached directly to the gear.

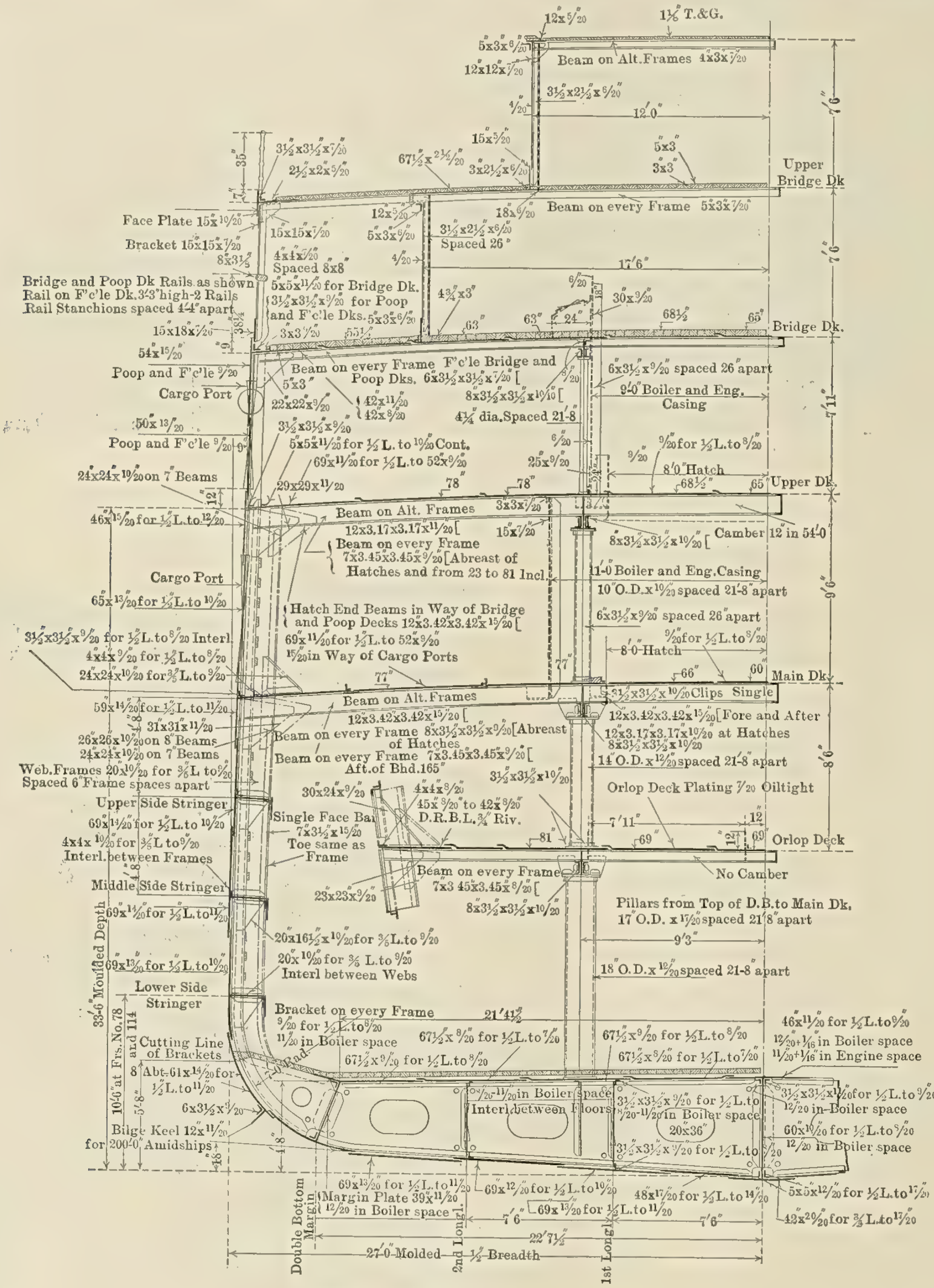
Life-saving equipment is provided for 335 people. There are nine 28-foot metallic lifeboats and one 20-foot wood yawl, all boats being handled by Welin quadrant davits. The vessel is equipped with a Nicholson ship log, with the Submarine Signal Company's receiving apparatus, and with wireless telegraphy.

An engineers' workshop, located adjacent to the engine room, is fitted with a lathe, drill press and double carborundum wheels, all power driven.

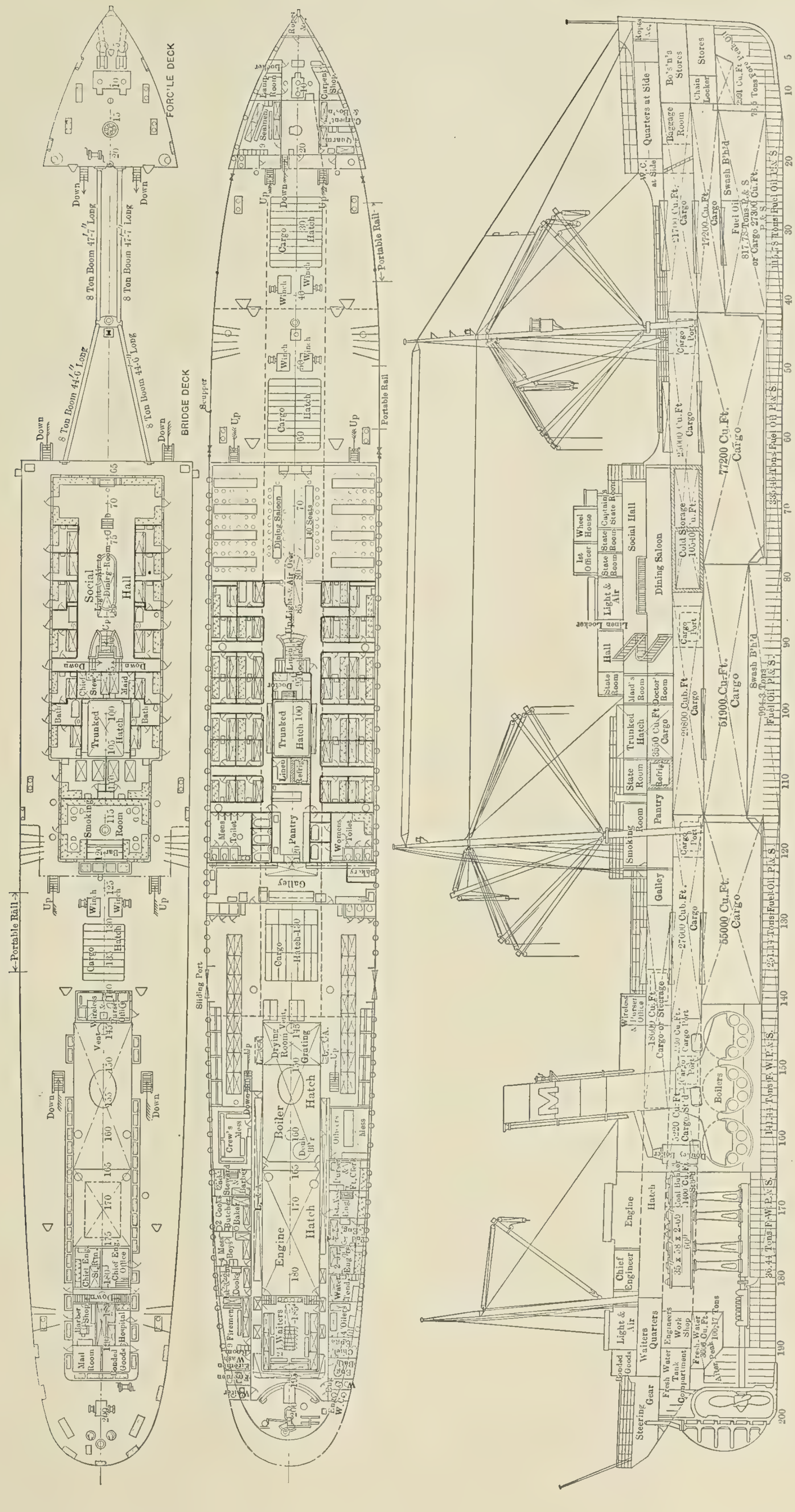
PROPELLING MACHINERY.

The propelling machinery consists of one four-cylinder triple-expansion engine and six main Scotch boilers. The cylinders are 35 inches, 58 inches and two of 69 inches diameter, respectively, with a 60-inch stroke, arranged with the high-pressure and medium-pressure cylinders in the center and the low-pressure cylinders at the ends. A separate liner is fitted in the high-pressure cylinder. One piston valve is fitted on the high-pressure, two piston valves on the medium-pressure cylinder, and each low-pressure cylinder has a double-ported balanced slide valve. All valves are worked by the Stephenson double-bar link motion, with direct-acting steam reversing gear; United States metallic packing is fitted to all piston rods and valve stems. All pistons are cast iron of box section, fitted with deep bull-ring and snap rings.

The piston rods are steel, all being 7¾ inches in diameter, and secured to the pistons and cross-heads in the usual manner with taper ends and nuts. The cross-heads are of forged steel with double cast iron slippers having white metal faces.



MIDSHIP SECTION, SHOWING SCANTLINGS.



GENERAL ARRANGEMENT OF THE WILHELMINA.

The connecting rods are forged steel, 11 feet 3 inches between centers, forked at the upper end to suit the cross-head, with gudgeon bearings of composition and crank-end boxes of cast steel lined with white metal. The crankshaft is steel, of the built-up type, with wrought iron webs. It is 19¼ inches diameter, and is made in two interchangeable sections. The sequence of cranks is high-pressure, medium-pressure, forward low-pressure and aft low-pressure.

The bed plate is cast iron of box section, made in three pieces, and has eight main bearings. The main bearing boxes are cast steel lined with white metal, and have wrought iron binders. The housings are also made of cast iron of box section, and have cross-head guides both front and back. The thrust bearing is of the horseshoe type, and the propeller is a four-blade sectional one, with manganese bronze blades. The surface condenser is independent of the main engine, and is made cylindrical with a plate shell. The circulating pump is of the centrifugal type, driven by a single-cylinder, direct-acting engine, and the main air pump is an independent, vertical twin Blake pump. There is also an independent auxilary air pump for port use. All pumps are independent of the main engine, and were furnished by the Blake & Knowles Steam Pump Works. These comprise a vertical twin main air pump, a vertical simplex featherweight auxiliary air pump and donkey feed, fire and bilge, ballast, sanitary, engine-room bilge, fresh water, two evaporator feed and three fuel oil pumps, all horizontal duplex. A Reilly feed heater and Ross grease extractor are fitted; also an evaporating plant consisting of two Reilly evaporators having a capacity of 20 tons in twenty-four hours, and one Reilly distiller of 2,000 gallons capacity in twenty-four hours.

The six main boilers are each 15 feet 4 inches diameter by 12 feet long, built for a working pressure of 190 pounds. Each boiler has four furnaces, 39 inches diameter, with a separate combustion chamber for each furnace and with 364 3-inch tubes. The total grate surface is 486 square feet, and the heating surface 17,070 square feet. Steam drums are fitted on each main boiler.

The donkey boiler is vertical, 5 feet 6 inches diameter by 9 feet 6 inches high, with a submerged head, built for 140 pounds working pressure. The main boilers are arranged to burn fuel oil with steam atomization, and the donkey boiler is arranged for using both coal and oil.

CLASSIFICATION.

The vessel and its equipment, also the propelling machinery, are being built under Lloyd's special survey to Class 100 A1. The vessel will also be rated under the Ocean Mail Subsidy Act of March 3, 1891, for which purpose an auxiliary fire main has been provided below the waterline, and foundations have been fitted for four 6-inch guns.

Lloyd's Register of Shipping—Annual Report, 1908-9.

At the close of the year ended June 30, 1909, 10,424 merchant vessels, registering over twenty and one-half million tons gross, held classes assigned by the committee of *Lloyd's Register*. The details are as follow:

Material of Construction.	Descript'n	British.		Foreign.		Total.	
		No.	Tonnage.	No.	Tonnage.	No.	Tonnage.
Iron and steel......	Steam...	6,095	12,280,467	2,899	6,390,392	8,994	18,670,859
	Sail....	511	836,109	710	1,031,616	1,221	1,867,725
Wood and composite	Steam & sail	197	27,056	12	3,936	209	30,992
Total...........	....	6,803	13,143,632	3,621	7,425,944	10,424	20,569,576

The serious depression which has existed for so long a time in the shipbuilding industry is again reflected in the amount of tonnage classed by the society during the year, which is considerably below the very high average attained in recent years.

Classes were assigned by the committee to 550 new vessels. Their registered gross tonnage amounted to 854,984 tons. Of these vessels, 481 of 845,719 tons were steamers, and 69 of 9,265 tons were sailing ships.

Of the total, 470,137 tons, or 55 percent, were built for the United Kingdom, and 384,847 tons, or 45 percent, for the British Colonies and foreign countries.

The most important fact which calls for mention in the work of the society during the past year is the completion of the task of revising the society's rules for the construction of steel ships, which occupied the attention of the committee for several months. The old rules, originally adopted many years ago, had been kept up to date by means of amendments and additions made by the committee from time to time, and proved sufficiently adaptable to be applied as a standard of strength to the various new designs produced by naval architects to meet the requirements of modern oversea trade. Of late years, however, the evolution of cargo-carrying vessels has made rapid progress, and the modification of many types had reached a stage at which it seemed that a general revision of the society's rules was desirable.

Since June, 1908, 44 steamers of upwards of 5,000 tons each have received the 100A1 class, and the following vessels, each of which exceeds 10,000 tons, have been assigned this classification since the issue of the last annual report, viz.:

Name of Vessel.	Tons.	Owners.
Chiyo Maru....................	13,426	Toyo Kisen Kaisha.
Osterley......................	12,129	
Otranto.......................	12,124	
Otway.........................	12,077	Orient Steam Nav. Co., Lim.
Orsova........................	12,036	
Morea.........................	10,890	Peninsular & Oriental S. N. Co
Malwa.........................	10,887	
Mantua........................	10,895	

It may be mentioned that during the period under review seven steamers, each over 8,000 tons gross, of which the turbine steamship *Chiyo Maru* is the largest, have been built in Japan to class 100A1, and in each case, except that of the above-named vessel, the machinery also has been made in that country.

At the present time, in addition to a fifth liner for the Orient Company, similar to the four previously mentioned, the new Cunard steamship, which is to take the place of the *Slavonia*, is being built to the society's highest class, as are also two new Union-Castle liners, each of 13,000 tons.

Reference may also be made to some other interesting vessels which have recently received, or are being built to, the 100A1 class, such as the two twin-screw steamers for the Canadian Government, the *Earl Grey*, to be used as an ice-breaker and specially fitted up for the passenger and mail service between the mainland and Prince Edward Island, and the *Simcoe*, for lake service, and constructed with special appliances for lifting light buoys; the *Monitoria*, built at Sunderland, representing a novel design of construction in the form of two corrugations worked in the shell plating of the sides, which, it is claimed, will have the effect of diminishing the resistance of the vessel Further reference may be made to the classification by the society of vessels built on Mr. Isherwood's longitudinal system of construction. Up to the present, thirteen vessels of this type with a total tonnage of 60,000 tons have been, or are intended to be, classed in the register book.

UPBUILDING THE AMERICAN MERCHANT MARINE.

To-day the American merchant marine engaged in foreign trade is practically extinct. We have but five steamships regularly crossing the Atlantic to Europe and only six regularly crossing the Pacific. We have no steamships under the American flag on routes to South America below the Isthmus and the Caribbean Sea, and none to Australia or to Africa. The tonnage of American ships engaged in foreign trade is to-day less than it was one hundred years ago. In 1810 approximately 90 percent of our exports and imports were carried in American ships, whereas to-day we are carrying less than 10 percent, and how much more the carrying of this trade means to-day than it did a century ago every one who is conversant with the great industrial and commercial growth of this country knows. It is sufficient to note that between $200,000,000 and $300,000,000 are paid annually to foreign steamship companies for this service.

THE CAUSE FOR THE DECLINE OF AMERICAN SHIPPPING.

The reason for the decline of American shipping in foreign trade is perfectly obvious. There is nothing mysterious or inexplicable about it. It is the natural result of lack of protection by the Federal government. The industry of carrying goods on the high seas is the one unprotected American industry.

Due to our system of protective tariffs, which has affected the cost of nearly everything that enters into the construction of a ship, including shipyard tools and machinery, workmen's wages, and, until recently, most of the materials, the total cost of an American-built ship anywhere from 50 to 100 percent greater than that of a foreign-built ship, precluding the thought of free competition in the foreign carrying trade.

When it comes to the operation of the ships, it is found that in accordance with our navigation laws American seamen must be paid wages ranging from 50 to 100 percent higher than those for foreign seamen, and that their standard of living must be such that the cost is approximately double that for a foreign ship.

Due, then, to high cost of construction and operation, the American ship without government aid of any kind has naturally disappeared from the high seas.

This condition of affairs is now becoming generally recognized throughout the country as one which is detrimental to the best interests of the nation, and one which should be rectified if there is a possible way to do it. In spite of the growing sentiment in favor of upbuilding the American merchant marine there are, however, some who still consider that this step is entirely unnecessary.

The up-building of the American merchant marine is justified by two very strong and convincing reasons. The first is that it would aid the commercial growth of the country by bringing merchants and manufacturers into closer touch with foreign markets, enabling them to take a progressive stand in export trade; and the second is that it is necessary to provide an adequate reserve force of auxiliary ships and men for our navy.

THE MERCHANT MARINE AS AN AID TO COMMERCE.

As to the first reason, it is true the exports and imports of this country are now enormous, and increasing rapidly each year, in spite of the fact that we are dependent upon foreign steamship lines for the carrying of about 90 percent of our goods. It is also true that this work is being done cheaply; but here any advantage in the present system ends. Carrying our commerce in American-built ships, officered and manned by American citizens, and sailed under the American flag, would not only widen old markets but would enable Americans to open up new markets for themselves instead of being obliged to follow the lead of their competitors.

The foreign trade of South America is increasing at the rate of $100,000,000 a year. China is awakening, and a few years will undoubtedly bring about an immense growth in her foreign trade. Japan's commercial activity is well known. In all this growth of trade and commerce the United States, on account of her vast resources and great industrial enterprise, has an opportunity for acquiring power, greatness and prosperity beyond the possibilities of any other nation. To expect to accomplish this, however, while dependent upon foreigners for the transportation and delivery of our products, is as absurd as to expect one merchant to out-distance a rival to whom he entrusts the important task of delivering his goods. This is precisely what we are doing at the present time, and the overwhelming disadvantages of such a policy are clearly apparent in the difficulties which our merchants and manufacturers encounter in entering the South American trade and staying there in competition with the direct and efficient mail and freight steamship lines which other nations maintain to that country. Every ship is a missionary of trade, and steamship lines mean as much to the development of the countries to which they belong as railroads do to their terminals.

IMPORTANCE OF THE MERCHANT MARINE TO THE NAVY.

The second important reason for upbuilding our merchant marine is the urgent necessity of providing an adequate supply of auxiliary ships for our large and otherwise well-equipped navy, and of forming a strong naval reserve from which recruits can be drawn for our warships in time of war. The present lack of such resource places us in a position that is at once humiliating and serious. Only recently we have had this fact impressed upon us in a vivid manner by the noteworthy voyage of our splendid fleet of sixteen battleships around the world, when they were attended by a heterogeneous fleet of foreign merchant vessels acting as colliers and supply ships. In time of war it might be extremely difficult to buy from foreign nations a sufficient number of such vessels to adequately support our navy, and this resort, even if possible, would probably prove extremely expensive.

No less important than the need of American merchant vessels suitable for scouts, colliers, and transports in time of war, is the need of a large and efficient naval reserve with which to man the fleet if occasion required. This feature of naval strength is one which is given great attention by other nations which have first-class navies, and it is a constant source of wonder and surprise to such nations that this prime necessity is neglected by the United States.

PROPOSED LEGISLATION.

Recent attempts to enact suitable legislation to upbuild our merchant marine, to promote our rapidly-increasing commerce with foreign nations, and to provide an adequate naval reserve for our navy, have been meeting with increasing measures of success. Only last year an act providing for increased mail subsidies to ships of 16 and 14 knots running to South America, the Philippines, China, Japan and Australia, passed the Senate by a unanimous vote, and was defeated in the House by the small margin of only three votes. Congress convenes again this month, and two bills have already been introduced into the House; one known as the Greene bill and the other as the Humphrey bill.

The Greene bill is a direct subsidy measure providing for the payment on each entry of a vessel of the United States not exceeding sixteen entries in any consecutive twelve months at the rate of $1 per 100 gross tons for each 100 nautical miles sailing outward and homeward bound, and also providing that owners, after receiving this compensation, are to go bond that they will within two years next after giving of such contract in good faith for the building in the United States of a new

vessel or vessels of an aggregate gross tonnage at least equal to 25 percent of the tonnage then existing on which compensation is claimed.

The Humphrey bill, on the other hand, is a mail subsidy measure, authorizing the Postmaster-General to pay for ocean mail service, under the act of March 3, 1891, in vessels of the second class, on routes of 4,000 miles in length outward voyage to South America, the Philippines, Japan, China and Australia, the rate per mile not exceeding the rate applicable to vessels of the first class, as provided in said act, and in vessels of the third class on said routes at a rate per mile not exceeding the rate applicable to vessels of the second class in said act, provided that the total expenditure for foreign mail service in any one year shall not exceed the estimated revenue therefrom for that year; sea-going steel steamers of 5,000 gross tons or over to engage only in trade with foreign countries or the Philippines, and wholly owned by citizens of the United States, may be built anywhere and registered, according to this act; but unless such ships are built in the United States they shall not be entitled to mail compensation as provided in this act.

It will be seen that the two foregoing measures are essentially subsidy measures, and since subsidy, either direct or in the form of mail compensation, has been the principal means proposed for the rehabilitation or our merchant marine, it becomes necessary to investigate to what extent and with what success subsidy is employed by other nations, and to determine, as far as possible, how well this means will accomplish the desired end in our own case, and, finally, to weigh carefully the possibilities of other methods which might be available.

AS TO SUBSIDIES.

First, as to the extent to which foreign nations are employing subsidies, the following abstract from the annual report of the Commissioner of Navigation for the fiscal year ending June 30, 1909, shows that eighteen foreign nations are paying annually the sum of $46,896,700 for mail subsidies, Admiralty subventions and navigation bounties as follows:

France	$13,423,737
Great Britain and Colonies	9,689,384
Japan	5,413,700
Italy	3,872,917
Spain	3,150,012
Austria-Hungary	2,984,530
Germany	2,301,029
Russia	1,878,328
Norway	1,102,143
Netherlands	880,011
Sweden	277,752
Denmark	145,000
Belgium	55,970
Portugal	50,000
Chile	253,195
Mexico	75,000
Egypt	54,512
Brazil	1,300,000

Also, that during 1908 the United States paid for the carriage of our ocean mails in American steamers $1,467,255, and to foreign steamers $1,228,032.

The foregoing figures are sufficient to show that the practice of subsidizing lines is practically universal with all maritime countries. In fact, as one writer has aptly expressed it, "Subsidy to shipping in some form or degree, either in the form of payments to regular mail lines, or to all ocean-going ships, is now as fixed a practice as is the use of the gold standard among progressive nations." China and the United States alone hold aloof from this policy, with the natural result that neither China nor the United States has a merchant marine engaged in foreign trade that is worth the name.

Whether or not subsidies are effectual in building up a merchant marine, the reader may judge from the fact that since 1890 British tonnage has doubled, German tonnage has trebled, and Japanese tonnage has increased tenfold. It is true that subsidies, as usually granted in the form of compensation for carrying the mails or as Admiralty subventions, benefit directly only the principal mail and passenger steamship lines, but indirectly a stimulus is given to the shipping of all kinds.

It is not, however, due to any doubt that subsidies will fail to build up the merchant marine in a substantial manner that this method is so stubbornly opposed. The chief objection is the time-worn argument that it is taxing the entire people for the benefit of a few. Why this should be such a serious objection in the case of ship subsidy we fail to see, since the same thing is being done on a far greater scale with the improvement of our rivers and harbors and with our land reclamation projects. As a matter of fact, from the point of view of promoting commerce with foreign nations, ship subsidies would benefit a greater number of people than either of these other undertakings; while from the point of view of furnishing our navy with an adequate reserve force of men and ships, the cost in the form of taxation should be considered no more seriously than is the cost of the navy itself.

OTHER REMEDIES AVAILABLE.

Two other methods for upbuilding the merchant marine have been proposed and defended with considerable vigor, one of which is the free-ship policy. The adherents of this policy maintain that if we were free to build our ships in foreign yards, where the cost of construction is so very much less, we would have no trouble in operating them at a profit.

No greater fallacy than this could be put forward. American capitalists who are now interested in steamship lines operated under foreign flags state that if American registry should be granted their foreign-built ships, they could not afford to take advantage of it, since they are able by maintaining their foreign registry to operate the ships at a lower cost, and also to take advantage of whatever subsidies the nations under whose flag the ships sail are willing to offer. If any further argument is needed to explode the free-ship theory, it is simply necessary to point to the experience which other nations have had with this policy. It has been given a thorough trial by such important maritime nations as Germany, France and Japan, and in each of these cases it proved a dismal failure, the total tonnage increasing very slightly and no stimulous to shipping in general being apparent. Each of these nations has unhesitatingly abandoned this policy for the more effective method of subsidizing.

The third method proposed is one which has already been tried in this country with excellent results. The very first act passed by the first Congress of the United States in 1789 provided thorough protection for American shipping by discriminating duties and tonnage taxes in both the direct and indirect trade. Under the stimulous of this protection our merchant marine grew until it outclassed that of any other nation, over 90 percent of our foreign commerce being carried in American ships. The chief objection to this method to-day, however, is the fact that we have some forty trade treaties with foreign nations, which prohibit any action of this kind. These treaties, our statesmen tell us, are so binding as to preclude the possibility of using this method.

The Shipping League of Baltimore.

Formal organization of the "Shipping League of Baltimore," which was instituted at a dinner given by Mr. Bernard N. Baker at the Maryland Club, October 13, was effected the following day at a meeting of the executive committee in the

Equitable Building, where the league will maintain its own regular offices.

Composing the committee are: Mr. Baker, former president of the Atlantic Transport Company and Baltimore Trust Company, and president of the league; vice-president, Robt. Ramsay, grain exporter; T. H. Bowles, president of Baltimore Trust Company; Norman James, lumber exporter; Waldo Newcomer, president National Exchange Bank; B. H. Griswold, Jr., of Alex Brown & Sons, and Lynn R. Meekins,

At first adopting a "declaration of principles," the committee authorized Messrs. Baker and Ramsey to draw up a plan of organization and defining the requirements of membership. Besides the sum of $15,000 subscribed at Mr. Baker's dinner, $5,000 additional has been subscribed, thus giving the league all the funds it needs for the present.

Briefly stated, the league will take a foremost position in whatever is done to build up American shipping, with the support of the administration at Washington. The main thing is to arouse every member of Congress in the South to the importance of developing the ports of the South.

PRESIDENT TAFT'S VIEWS ON THE MERCHANT MARINE.

President Taft's views on the upbuilding of the American merchant marine were clearly and forcefully expressed in a speech at Seattle on Oct. 1, an abstract of which is given below:

"We maintain a protective tariff to encourage our manufacturing, farming and mining industries at home and within our jurisdiction, but when we enter into competition upon the high seas in trade between international ports our jurisdiction to control that trade, so far as the vessels of other nations are concerned, of course, ceases, and the question which we have to meet is how, with the greater wages that we pay, with the more stringent laws that we enact for the protection of our sailors, and with the protective system making a difference in the price between the necessaries to be used in the maintenance of a merchant marine, we shall enable that merchant marine to compete with the marine of the rest of the world.

"This is not the only question, for it will be found upon an examination of the methods pursued in other countries in respect to their merchant marine, that there is now extended by way of subsidies by the various governments to their respective ships upward of $35,000,000, and this offers another means by which in the competition the United States ship is driven out of business, and finds itself utterly unable to bid against its foreign competitors. Not only this, but so inadequate is the American merchant marine to-day that in seeking auxiliary ships with which to make our navy of offense or defense, or indeed in sending around the world a fleet, we have to call on vessels sailing under a foreign flag to carry the coal and to supply the other needs of such a journey.

"Were we compelled to go into a war to-day our merchant marine lacks altogether a sufficient tonnage of auxiliary unarmed ships absolutely necessary to the proper operation of the navy, and were war to come on we should have to purchase such vessels from foreign countries, and this might, under the laws governing neutrals, be most difficult.

"The trade between the Eastern ports of the United States and South America is a most valuable trade, and now equals something like $250,000,000; but European nations, appreciating the growing character of this trade, have by subsidies and other means of encouragement so increased the sailings of large and well-equipped vessels from Europe to the ports of South America as visibly to affect the proportion of trade which is coming to the United States by the very limited service of a direct character between New York and South American ports.

"I need not tell you of the inadequacy of the American shipping marine on the Pacific Coast and the growing power for commercial purposes in this regard of the Empire of Japan. Japan is one of the most active and generous countries in the matter of subsidies to its merchant marine that we have, and the effect is only too visible in an examination of the statistics.

"For this reason it seems to me that there is no subject to which Congress can better devote its attention in the coming session than the passage of a bill which shall encourage our merchant marine in such a way as to establish American lines directly between New York and Eastern ports and South American ports, and between our Pacific Coast ports and the Orient and the Philippines.

"We earn a profit from our foreign mails of from $6,000,000 to $8,000,000 a year. The application of that amount would be quite sufficient to put on a satisfactory basis two or three Oriental lines and several lines from the East to South America. Of course we are familiar with the argument that this would be contributing to private companies out of the Treasury of the United States, but we are thus contributing in various ways on similar principles in effect both by our protective tariff law, by our river and harbor bills and by our reclamation service. We are not putting money in the pockets of shipowners, but we are giving them money with which they can compete for a reasonable profit only with the merchant marine of the world.

"From my observation I think the country is ready now to try such a law and to witness its effect in a comparatively small way upon the foreign trade of the United States. If it is successful, experience will show how the policy can best be expanded and enlarged, and the American commercial flag be made to wave upon the seas as it did before our Civil War. It is true that our foreign trade is great and increasing, and this without the merchant marine, but it is also true that the ownership of a merchant marine greatly enhances the opportunities for extending trade for the merchants of the country having such a merchant marine."

"AMERICAN SHIPS AND THE WAY TO GET THEM."

One of the ablest expositions of the views of the adherents of the ship subsidy policy for the upbuilding of the American merchant marine appeared under the above title in the October number of the *Atlantic Monthly*, from the pen of Winthrop L. Marvin, formerly secretary of the Merchant Marine Commission.

Regarding previous protective measures for American shipping, Mr. Marvin says:

"The first Federal Government in 1789 had found the American merchant marine almost as shrunken and dead as it is now—a mere skeleton of 123,000 tons, capable of carrying only a fraction of our commerce, which was conveyed as now largely by British shipping. But the statesmen of 1789, in their very first tariff act, 'for the protection and encouragement of manufactures,' embodied stalwart protection for American ships and sailors through the form of discriminating tonnage and customs taxes, which compelled American merchants to employ the ocean carriers of their own country—and the law required that these ocean carriers should be built in the United States.

"This bold protective measure, which Washington and Madison joined in framing and enforcing, proved so successful that by 1800 our registered merchant fleet had expanded to a

tonnage of 667,000, carrying 89 percent of our imports and exports, and by 1810 to a tonnage of 981,000, carrying 91 percent of our imports and exports. These policies of ship protection, though modified here and there in the years that followed, were not entirely withdrawn against Great Britain, our chief competitor, until 1849, and by that time they were reinforced by a generous system of mail subsidies, which rapidly developed steamship-building and engine-building in the United States, and gave to our ocean steam fleet a growth in quantity and quality far superior to that of the United Kingdom. These early American mail subsidies, by the way—it is worth recalling now—had been granted by Democratic Congresses, on the recommendation of Southern Democratic Presidents. They created several American steam lines to Europe, with which the feebler and slower British subsidized ships could not compete, and other lines to the West Indies and in the Pacific Ocean.

"The American merchant marine, as it stood at the height of its strength in 1855, when 583,000 tons of shipping were launched in the United States, was the result of a system of national protection deliberately initiated in 1789 by the founders of the Federal Government. Even through these periods, when low-tariff or anti-protection theories had prevailed in Congress and the country, the merchant marine was sedulously fostered by discriminating duties, and later by subsidies to mail lines, while all the time direct bounties were paid to the vessels and men of the deep-sea fisheries—'the nursery of the navy.' There was small protection then for pig iron and cotton cloth, but much protection for ships and, therefore, for shipbuilding. This maritime interest up to 1855 was unquestionably the most progressive, efficient and prosperous interest in America.

"The American merchant marine had prospered and grown amazingly under national protection, and it began to shrink as soon as that protection was withdrawn.

"Every Republican President since Grant has earnestly recommended the upbuilding of the merchant marine, through the form either of mail subsidies to regular lines or of subsidies to the whole body of our ocean shipping. McKinley and Roosevelt were especially insistent on a subsidy policy, and under the administration of President Harrison something was actually done—the enactment of an ocean-mail law which has stood to the present time, and has created the one American steamship line to Europe and excellent lines to the West Indies, Mexico and near ports of South America. But this legislation of 1891 was not liberal enough to sustain steamship lines to the farther and principal South American countries and across the Pacific Ocean."

Mr. Marvin outlines the present situation as follows:

"Here, in a nutshell, is the problem of the American merchant marine. We have established a protective system, and we have left out of that system the industry of the ocean shipowner. We have thereby killed that industry, exactly as we would have killed the manufacture of cotton goods or woolen goods if we had left that industry alone out of the protective system. The manufacturer could not buy his labor and materials in a protected market, and yet sell his product under terms of free-trade competition with all the world. The shipowner has not been able to buy his labor and materials in a protected market—it is only of recent years that materials have been free—and yet sell his product, which in this case is the service of his ship, under terms of free-trade competition with all the world; or, worse, under terms of free-trade competition, frequently aggravated by the bounties or subsidies of other governments.

"On all of the important routes of the world's commerce, the dominating factors in transportation at the present time are the great national mail-subsidized lines of foreign governments."

Regarding the relative efficacy of the "free ship" policy and the ship subsidy policy, Mr. Marvin has this to say:

"It is simply paltering with a great and vital national question to plead that a 'free ship' policy—that is, the purchase of American ships in British yards—would of itself enable American ship owners to meet the conditions with which they are confronted in the Pacific and Atlantic Oceans.

"Germany in the beginning tried the 'free ship' expedient alone, having no shipyards in which either merchant craft or men-of-war of large size could be constructed. The experiment was a complete and acknowledged failure, the German mercantile tonnage, increasing only from 1,098,000 in 1873 to 1,243,000 in 1881. Then Bismarck appealed to the Reichstag for a positive and liberal policy of State aid through mail subsidies, preferential railroad rates, and other potent forms of imperial encouragement. Now the real growth of the German merchant marine began, and the tonnage of the Empire rose to 2,650,000 in 1900, and to 4,232,000 in 1908.

"The experience of France was similar. After a long and patient trial of 'free ships,' the French people found themselves in 1881 with actually a feebler ocean fleet (914,000 tons) than they had possessed in 1870 (1,072,000 tons). In sheer desperation at the utter failure of the 'free ship' experiment, the French government resorted to subsidy and bounty on an extensive scale. The records of the Bureau Veritas show that the French mercantile marine, which was 914,000 tons in 1881 has actually doubled to 1,952,000 tons in 1908—the later increase consisting chiefly of steamships of high character.

"But perhaps the most striking recent example of the success of State aid in the creation of an ocean shipping is the experience of Japan. There, too, the first reliance was placed on a 'free-ship' policy, and there, as elsewhere, while depended on alone, this ignominiously failed. In the war with China in 1894, Japan found herself with only about 200,000 tons of ocean vessels, and with almost no facilities for repairing, not to say building, them. The Japanese statesmen thereupon launched out upon the most generous and comprehensive system of subsidy and bounty, encouraging both 'tramp' ships and regular lines, and developing native shipyards by the expedient of granting a bonus for every ton of ocean shipping constructed. In ten years the Japanese merchant marine had grown from the 200,000 tons of 1894 to 830,000 tons. The total for 1908 is 1,243,000 tons, and the Japanese payments for subsidy and bounty, exclusively to Japanese ships, are not far from $6,000,000 a year.

"China and the United States are the only important governments which have held aloof from the modern policy of direct and liberal national aid to the merchant marine. Subsidy to shipping in some form or degree—in the form of payments either to regular mail lines or to all ocean ships—is now as fixed a practice as is the use of the gold standard among progressive nations.

"This does not mean that the policy of 'free ships' is totally discredited and abandoned: it is simply condemned as insufficient in itself without some form of direct protection and encouragement to native shipbuilding and to navigation. As a rule, the governments which grant subsidy or bounty also allow their people to purchase foreign-built ships, but such ships are usually excluded from the benefit of a part or all of the subsidies, and especially is it required that the faster steamships, the auxiliary cruisers, of the national mail lines shall be of native construction. This, as has been said, is the policy of Germany, and in British mail contracts like that of the Cunard line it is stipulated that the subsidized ships shall be 'built in the United Kingdom.' Unless it be China, or perhaps Russia, no nation now adheres to an absolutely unrestricted 'free-ship' policy, with no thought of native shipbuilding."

PRACTICAL EXPERIENCES OF MARINE ENGINEERS.*

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs as Told by our Readers.

Repairing a Broken Crankshaft at Sea.

The breakdown occurred on board a foreign-owned passenger and cargo vessel in which the writer was serving. The ship was an old one, having been built in the early sixties, with exceptionally heavy scantling. It was driven by compound engines, supplied with steam at a working pressure of 60 pounds per square inch. The shafting was about twenty-five years old, but showed no outward sign of deterioration, and the first indication of anything being wrong was the discovery by the engineer on watch of a fore-and-aft movement on the tunnel shaft, and up to the after main bearing. The forward end of the crankshaft was running perfectly true,

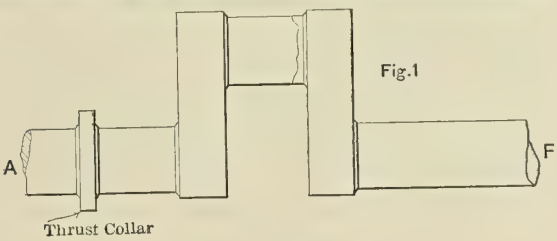


Fig.1

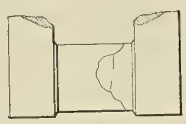


Fig.2

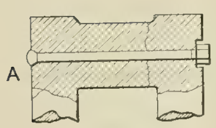


Fig.3

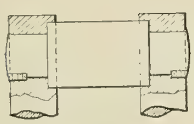


Fig.4

and there was no undue heating of any part of the engines. A light, fair breeze was blowing, with a short and choppy following sea, causing a slight, easy racing of the engines.

Immediately the discovery was made the engines were slowed down and an examination hurriedly made. The inspection showed that the low-pressure crank pin was broken. The engines were then stopped, the captain advised, and the crankshaft dismantled. After dismantling, the fracture of the crank pin was found to be at a point close to the bottom of the fillet, and extending almost half way round, taking afterwards a diagonal course across the pin and out towards the center, as shown in Figs. 1 and 2.

The loose particles of the metal were cleaned off, the parts brought together in position, faired, and firmly secured in place by fitting a band around the pin, the band being drawn firmly together with bolts and nuts. Wedges were driven in between the webs and the engine seating, to enable a hole to be drilled through the webs and the center of the crank pin. The only material available for making a bolt suitable was a tie rod 2 inches in diameter, taken from the deck fittings. Drills were forged from a steel bar to suit this size, and drilling operations commenced. When the hole was drilled through the 32 inches of metal, it was not 1/16 inch out. One end of the hole was countersunk to receive the head of the bolt, and the other end was recessed to receive the nut, as shown in Fig. 3. The bolt with a countersunk head and 1½-inch screw, this being the largest-sized die on board, was then fitted and tightened up without putting any undue strain on it. The crankshaft was then coupled up, the engine started at a slow speed, which was gradually increased up to forty-two revolutions per minute, and at this speed the ship made her port two and a half days later, and only 40 hours late.

It will be observed that the end of the fracture, acting as a clutch, assisted considerably in reducing the shearing strain on the bolt, and also saved a good deal of labor. If the break had been a through one, more than one bolt would have been required, as, with the drilling appliances available, a larger diameter of bolt could not have been fitted.

On arrival in port it was decided to repair the shaft rather than wait for a new one, which would have involved considerable delay. The broken pin was cut away and eye-ways bored out in the webs to receive the new pin. A new pin was made, 12 inches in diameter, the eyes being turned out to this size 2 inches deep, and then reduced to 7 inches in diameter on the forward web, and 8 inches diameter on the after web, with a countersink on each, as shown in Fig. 4. The new pin was carefully finished off and shrunk into place. The ends were riveted over, following up the countersinks, and to prevent any possibility of the pin moving, two 1½-inch tapping holes were drilled, half in the pin and half in the web, tapped, and pins fitted into them and riveted over.

With the crankshaft so repaired the ship made two and a half voyages, covering a distance of about 20,000 miles, and during that time the shaft gave no trouble. It was then replaced by a new one, the repaired shaft being retained as spare. JAMES BELL, R. N. R.

The Emergency Man.

A small government steamer in the service of the National Board of Health was at one time 65 miles from her station on an important mission in connection with yellow fever. This vessel did not require licensed officers, but the rule was to employ them when licensed men could be obtained who cared to take the risk. On this occasion the master of the vessel was only nineteen years old, but he found a way to get his boat back to her station, where repairs could be made, after a licensed engineer had failed completely, giving up the job in disgust and stating that they would have to go somewhere for assistance with a small boat or else wait for some passing craft to pick them up.

The trouble was with the check valves in the feed line, which failed to function, cutting off the supply of water to the boiler. Of course, as soon as the trouble had been discovered, the fires had been drawn and the boat anchored.

The nineteen-year old captain then proceeded to use his ingenuity by making blank flanges in place of the feed-water connection. He then proceeded to fill the boiler with buckets through the safety valve, and after this was done started the fires again. It was found that the boat could make from 15 to 20 miles on every boiler full of water, according to the state of the tide, or on every tack, as a sailor would say. By continuing this performance the youthful captain was able to get his boat back to her station. VERITAS.

* We pay for these articles.

Raising a Sunken Tug.

The photograph shows a tug which sank in about 14 feet of water at her dock. She was raised by placing three steel wire hawsers under the boat and taking the ends to pitch pine timbers, which were placed across and supported one end on the wharf and the other end on a large scow which had been filled with water. Hydraulic jacks were then placed under the ends of the timbers at the wharf and pumped up while the scow was being pumped out. By this means the tug was raised until her rail was level with the water. A

ARRANGEMENT OF TIMBERS FOR RAISING A TUG.

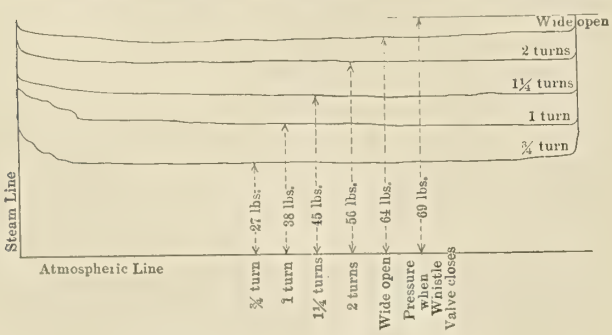
centrifugal pump with an 8-inch suction was then let down through the deck into the cabin and a fire engine and three tug boats pumped the water out of the boat.

At the first attempt the centrifugal pump was stopped by an oil cloth off the mess room table being drawn into the strainer. When this was cleared, however, she was pumped out in about three-quarters of an hour.

Before raising her an attempt was made to pump the boiler out, a pipe being passed down through the dome between the tubes, but since the sea cock on the feed pump had been left open the water flowed in through the checks as fast as the boiler was pumped out. J. F. W.

Steam and Water Test of a 12-Inch Chime Whistle.

The following test was undertaken to show the amount of water used by a 12-inch steam chime whistle according to the pressure in the whistle pipe. The pressure on the gage at the time of the test was 70 pounds per square inch. A 3-inch Williams valve was fitted to the pipe as a stop valve, this being opened at different times three-quarters, one, one and one-quarter and two turns and wide open. Indicator cards were taken showing the drop of pressure in the steam pipe at these different positions of the valve, with the results shown in the illustration. The valve stem was threaded where it passed through the yoke, with threads having a pitch of 6 to the inch. The whistle was allowed to blow 10 seconds each minute.



INDICATION CARDS FROM WHISTLE PIPE.

The computations made to determine the number of gallons of water discharged per hour were as follows:

The velocity of steam in feet per second was multiplied by the length of the blast in seconds per minute, giving the lineal feet of steam per minute; and this multiplied by the area of the pipe gave the number of cubic inches in 1 minute, which, in turn, was reduced to cubic inches per hour. This result was then divided by the cubical proportion of the water discharged, the result, in turn, being reduced from cubic inches to gallons, giving the number of gallons of steam and water discharged per hour.

Valve open one turn, pressure 38 pounds:

$1{,}800 \times 10 = 18{,}000$ feet per minute.

$18{,}000 \times 7.0686 = 127{,}234$ cubic inches per minute.

$$\frac{127{,}234 \times 60}{673.7 \times 231} = 48 \text{ gallons per hour.}$$

Valve open one and one-quarter turns, pressure 45 pounds:

$2{,}000 \times 10 = 20{,}000$ feet per minute.

$20{,}000 \times 7.0686 = 141{,}372$ cubic inches.

$$\frac{141{,}373 \times 60}{563 \times 231} = 65 \text{ gallons per hour.}$$

Valve open two turns, pressure 56 pounds:

$2{,}200 \times 10 = 22{,}000$ feet per minute.

$22{,}000 \times 7.0686 = 155{,}320$ cubic inches per minute.

$$\frac{155{,}320 \times 60}{467.9 \times 231} = 86 \text{ gallons per hour.}$$

Valve wide open, pressure 64 pounds:

$2{,}300 \times 10 = 23{,}000$ feet per minute.

$23{,}000 \times 7.0686 = 162{,}577$ cubic inches per minute.

$$\frac{162{,}577 \times 60}{412.6 \times 231} = 102 \text{ gallons per hour.}$$

INVESTIGATOR.

Main Engine Repairs Under Way.*

On Dec. 13, 1908, the *Kansas* arrived at Colombo, Ceylon, where the fleet was scheduled to remain one week. Such routine overhauling and examination as was possible was begun as soon as the engines were cool; this naturally included the removing the bull's-eyes from the cylinder bonnets, and examining and oiling the interiors. The port engine cylinders were first opened, and everything was found to be in good shape. On the 16th work was begun on the starboard engine, and when the high-pressure cylinder was opened a very remarkable state of affairs was disclosed. There were seen to be two parallel scores, ⅜ inch deep and 1 inch wide, cut neatly in the liner on the forward side, and, in addition, a bad shoulder had been worn on the outboard after portion of the circumference near the top. Removal of the piston follower developed the fact that the packing ring was broken in five pieces, one of which was missing. Although searched for in the other cylinders and valve chests, no traces of the missing piece have ever been found. Probably it has been ground up, or else it remains hidden in some receiver space.

The place of the missing piece had been taken by the forged steel clamp which, as shown in Fig. 1, held the ends of the ring together, making the whole equivalent to a solid ring. This clamp was very securely held in place by the pieces of broken ring and bent and broken springs, and formed a splendid planing tool. The fact that the remaining portion of

* From the Journal of the U. S. Naval Institute.

the ring was unable to move in the piston was probably responsible for the shoulder.

The damage had been done while en route from Manila, as all cylinders and rings had been examined prior to leaving that port. There was no indication of anything wrong inside the cylinder on this run, except an occasional clicking, to which little attention was paid, as the metallic packing has frequently caused exactly the same sound. The increased coal expenditure was noticed, but was attributed to the stay in Manila Bay, where vessels foul very rapidly. Indeed, on arrival at Colombo, the propellers were examined by divers, and found to be thickly covered with good-sized barnacles. When these were removed it was expected that the coal consumption would resume its former ratio to that of the other vessels of the *Kansas* class. But this was before the damage to the S. H. P. liner was discovered.

There were but three days left of the stay in Colombo, and repairs of any description were out of the question in that time. Remaining behind was just as much out of the question. For almost exactly one year the fleet had remained intact, had made its runs on schedule time, and, judging from newspaper comment, had won the admiration of the world. To confess that one vessel was in such condition as to be unable to proceed would be to admit that a fleet of battleships could not make a cruise around the world. It was, therefore, essential that the *Kansas* leave Colombo on Dec. 20, and that she accompany the fleet during the rest of the cruise. Of course, running under one engine would allow her to proceed, but her maneuvering qualities would be practically nil, and her coal consumption would be so enormous as to necessitate her putting in at Aden. This would again upset the plans of the commander-in-chief, who had reported that the fleet would be at the Canal by Jan. 4.

Had it not been for the bad shoulder in the liner, both engines could have been run without attempting to stop the leakage of steam through the scores, and the coal consumption would probably not have been much greater than on the run from Manila to Colombo. Had the spare ring been installed without removing the shoulder and truing up the liner, it is almost certain that the ring would have broken and caused additional damage. It was clearly necessary to rebore the liner, although unsafe to bore out enough to remove the scores, which, as mentioned, were ⅜ inch deep, while the thickness of the liner wall was 1½ inches, the working pressure being 250 pounds in the high-pressure valve chest. The filling of the scores would save steam, and the removing of the shoulder would allow a new ring to be fitted without incurring risk of breaking it immediately.

The piston and rod were removed, the liner was lifted out of the cylinder and hoisted to the superstructure, and the work of compounding the starboard engine was begun. This consisted in replacing the cylinder bonnet, removing the connecting rod, high-pressure valve, piston and rod, plugging the piston-rod hole, and blocking the steam ports with the valve rings, which were pressed out by improvised spiders. This was to prevent the high-pressure cylinder from acting as a condenser by presenting a large cooling surface to the incoming steam. The crank pin was carefully wrapped with burlap to keep it from being damaged. The cross-head was secured in place on its guide.

The liner could have been swung in the large gap lathe in the ship's workshop, but, unfortunately, the shop door was too narrow, and cutting away the bulkhead would consume considerable time. The commander-in-chief had ordered the *Panther* to afford all possible aid, and accordingly a boring bar and motor were borrowed from her.

On the morning of Dec. 20 the *Kansas* left Colombo with the fleet, and took her regular place in column. She took part in all tactical exercises, which were held daily, and no difficulty was experienced in handling the starboard engine. The coal consumption was increased to some 15 percent above normal, and approximated very closely to the consumption on the run from Manila, when the engine had been run with the broken ring.

The actual repair work was begun as soon as the vessel cleared the breakwater. To carry out the plans it was necessary to bore out the shoulder, fill in the large scores, enlarge the piston and follower, and make a new ring, as the spare would be useless after reboring. Various materials suggested themselves as suitable for filling in the scores. It was finally decided to fit cast iron strips, as the Babbitt metal on board might run, and "Smooth-On" would probably crack off and ruin all the other cylinder liners. To fit these strips, the sides and bottoms of the scores had to be exactly true, and, while the clamp in its capacity of planing tool had done a very good job, the scores were not absolutely straight. The milling out

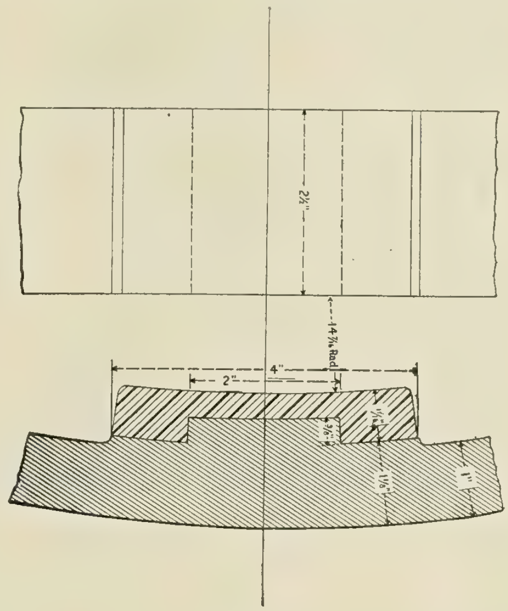


FIG. 1.

of the scores was successfully done by an ingenious device invented by Machinist E. G. Affleck, U. S. N., who had complete charge of the repairs, and who, by working day and night, pushed them to a speedy and successful termination.

The liner was laid in a horizontal position on the superstructure near the engine-room hatch, and that part of the ship was roped off so that the mechanics could work without interruption. A wooden dam was built to keep the water away from the liner and motor while the decks were being washed.

Splendid weather and a smooth sea favored the undertaking. In addition, the Red Sea did not live up to its reputation and the men did not suffer from the heat.

After the scores had been milled, the cast iron strips, made from the furnace-door lintels, were accurately fitted, and driven in place. They were then drilled, and ⅜-inch studs were tapped into both the strips and the liner. It is unfortunate that the strips could not have been each in a single piece, but the material available on board demanded that each score be filled by inserting three strips end to end. As will be seen later, the strips were not entirely successful, and were removed.

The scores being filled, the boring bar was rigged, and three cuts were taken, each cut requiring about ten hours. The liner, after boring, was 33 inches in diameter, whereas the original design called for 32½ inches. The tool was set by assuming the counterbore to be concentric with the liner, and this assumption proved to be justifiable, for careful calipering

showed that the liner had been bored exactly true, and, when afterward set in place in the cylinder, was perfectly in line.

While the work of boring was going on the piston and rod had been centered in the large lathe, and a cut taken from the piston and follower. Fig. 2 shows the original arrangement, while Fig. 3 illustrates the conditions after the enlargement. The intention was to shrink solid cast iron rings on both piston and follower, and then to turn the whole to suit the new diameter of the liner. A casting of sufficient size to make both enlarging rings, as well as a new packing ring, had been obtained from stock on the *Panther* before leaving Colombo. The shrinking-on was successfully done, but it was while finishing the enlarging rings that a very serious setback was received. One cut was sufficient to disclose the fact that the

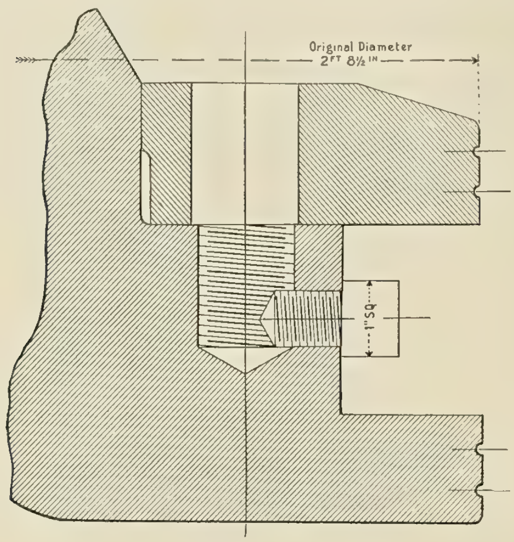


FIG. 2.

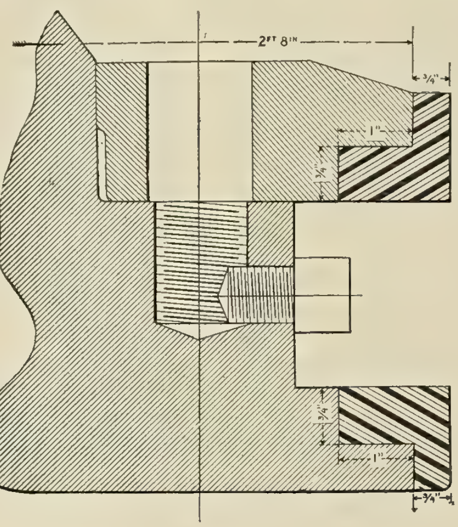


FIG. 3.

casting was so badly honeycombed as to render it useless. Fortunately, the packing ring, made from the same casting, turned out to be sound. It was now necessary to resort to some other expedient, and time was getting short, since the possibility of bad metal had not been figured into the calculations. The engineer's blacksmith took the only piece of 2-inch square steel on board, bent it to a perfect circle of the proper diameter, and welded the ends together. As blacksmithing has to be done in the fire-rooms, where the foundations for the anvil are none too solid, and as all work has to be done by hand, this piece of work may well be considered an exceptional job of ship's blacksmithing. These two blacksmiths, T. Lentz and J. Mullins, deserved the received special commendation for this exhibition of skill.

Two such rings were needed; the second one was ordered by wireless from the *Panther,* and put aboard the *Kansas* on arrival at Suez. Both rings were shrunk on by the engineer's blacksmiths, and the work of turning them up was begun when the ship started through the Canal.

The fleet arrived at Suez on Jan. 3. The first division, comprising the *Connecticut, Vermont, Minnesota* and *Kansas,* proceeded through the Canal on the morning of Jan. 4, and tied up at Port Said about 1 A. M. Jan. 5. Coaling was begun at once, and while in progress hurry orders were received to get out at daylight, Jan. 6, in order to reach the vicinity of the Messina disaster as soon as possible. This left about twenty-eight hours in which to complete all repairs to the starboard engine, and it was not possible to begin work on the engine itself for four hours, on account of the heat of the metal.

Turning the ring received from the *Panther* took a great deal more time than it should have, as it was made of the hardest kind of steel. Taking one light cut made regrinding the Armstrong tools necessary, and these were made of the highest grade of self-hardening, high-speed steel.

When the engines were cool, the liner was secured in the cylinder, the joint under the flange was made, the connecting rod was swung back into place, the cross-head and crank-pin brasses were adjusted, the compounding devices were removed, the piston and rod were put in place, the high-pressure valve was installed and set, the new ring was accurately fitted, and the ship got under way at 14-knot speed at 5 A. M., Jan. 6, headed for Naples.

The repairs thus effected were successful, except that on arrival at Villefranche (to which port the ship had been diverted while passing through the Straits of Messina) one cast iron strip was missing, while another was found to be cracked. Accordingly, the remaining strips were removed, the scores were dovetailed, and white metal from a spare set of United States metallic packing was poured in hot, and peened and scraped in place. On arrival at the Navy Yard, Philadelphia, the liner was in splendid condition, and the places where the scores had been filled in could scarcely be seen.

It is calculated that the rate of coal consumption was practically the same coming from Manila to Colombo, with the ring broken, as it was from Colombo to the Canal with one engine compounded. On the runs from Villefranche to Gibraltar, and thence home, the consumption was decreased 15 percent, resulting in a saving of 230 tons in 4,600 miles.

Lieut. E. C. Kalbfus, U. S. N.

The Bureau of Navigation of the Department of Commerce and Labor, Washington, D. C., reports that ninety-three ships, both sail and steam craft, were built and officially numbered in October. Of this number more than one-half were constructed for service on the Atlantic and Gulf coasts. Only six were steel steamers. The vessels were small, their total being only a little over 4,000 gross tons.

Recent launches of naval vessels in Britain include the battleship *Neptune,* the battle cruiser *Indefatigible,* and the second-class cruisers *Gloucester* and *Liverpool.* The *Neptune* is an advanced type of Dreadnought, capable of firing all of her ten 12-inch guns on either broadside. The *Indefatigible* will be the most powerful cruiser in the world, with a speed of 26 knots. The two second-class cruisers are of the Bristol class, having a displacement of 5,000 tons and a speed of 25 knots.

SEVENTEENTH ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The seventeenth annual meeting of the Society of Naval Architects and Marine Engineers was held in the Engineering Societies building, New York, Nov. 18 and 19, 1909. During the year a special effort was made to increase the membership, and, according to the report of the secretary-treasurer, seventy-five new members were elected during the year. There was a membership of 765 Nov. 1, 1908, whereas the figures for Nov. 1, 1909, were 795. Forty-seven new members were elected at the present meeting. The total receipts for the year were $10,063.23 (£2,066), and the total disbursements, $12,785.08 (£2,625). The total resources of the society at present are $24,575.21 (£5,046), with no liabilities against it.

PAPERS READ NOVEMBER 18.

No. 1—Evolution of Screw Propulsion in the United States.

BY CHARLES H. CRAMP.

ABSTRACT OF PART I.

Between the first and second quarters of the last century, the principal machine shops of Great Britain were in a prosperous condition, abundantly supplied with good tools and numerous skilled workmen; while the machine shops in the United States were few in number, limited in size and capacity, and the workmen, with but few exceptions, lacked experience and skill. The relative conditions between the machine works of the two countries remained the same until the year 1870. It was on this account that the screw-propeller, invented by Col. John Stevens in 1804, was not utilized.

The screw of Colonel Stevens of 1804 was practically developed in Kensington by the Penn Works of Reaney, Neafie & Company half a century later, and the hull of the *New Jersey,* which was designed by the best ability in England, was adopted by William Cramp in the screw tug *Sampson,* which was engined by the Penn Works, the propeller of which boat was practically that of Colonel Stevens.

Screw propulsion had already become a factor in navigation, and there was a general desire to develop it, particularly in Philadelphia, during the decade between 1834-1844. All were in a receptive mood, the atmosphere was highly charged with it, and was ready for the great transition when John Ericsson made his appearance in 1840, preceded by the *Robert F. Stockton,* which came over from England under sail the preceding year.

After Mr. Ericsson's arrival here in 1840 he made the acquaintance of Mr. Thomas Clyde, who soon became a convert to the propriety of screw propulsion, and he was the first shipowner to adopt it in this country. A pair of screws was fitted to the *J. S. McKim,* which he used in his Gulf trade, and afterwards as a transport in the Mexican War. The engines were built in a shop in the Old Northern Liberties, of Philadelphia, and Mr. Neafie, afterwards of Reaney, Neafie & Company, was engaged on them as a young man, and it was to this fact that Mr. Neafie took early interest in screw propulsion. Later on, when the firm of Reaney, Neafie & Company was established in 1840, screw propulsion had come to stay, and was the practical ending of the Ericsson screw.

While Mr. Ericsson had accomplished so much in the education of the public mind in favor of screw propulsion, he was not so successful in the introduction of his particular screw; it proved exceedingly defective, and none were used the second time.

The original screw of Colonel Stevens was replacing all others, but not under his name. The favorite screw of Reaney, Neafie & Company was the "Loper patent." Captain Loper had bought the patent from a workingman, and I think he died without knowing anything of its resemblance to the Stevens propeller. Mr. Clyde had adopted it, and had transferred his work to Reaney, Neafie & Company. The Ericsson Line adopted a screw of their own which was much similar to the Stevens.

Thomas Murphy, the chief engineer of the Ericsson Line, was a highly competent and superior man, and he adopted a plan to simplify the construction and repair of "his wheels"; the repairs being frequent made it very costly. Besides, he took advantage of every change he made in their form to secure information as to the results, subjects that still continue to puzzle all marine engineers—the proper relationship between the pitch, diameter, the surface area and the revolutions. He secured a vast fund of information from his multitude of experiments. I do not know whether he left any record with the company after his time, but I do know that the Penn Works profited vastly by his experiments.

The particular object of Mr. Ericsson's visit here was more on account of the introduction of a certain type of engine for warships than of his peculiar screw. He had interested Commodore Stockton in the warship question at an early date, when he met him in England. The Commodore prevailed on the United States Government to build a ship which was named the *Princeton,* and Mr. Ericsson was occupied from September, 1841, to September, 1843, in preparing the plans of the machinery. It is impossible to find in the world's history of naval construction where there had been so great a flourish of trumpets over the building of a ship, with such little results afterwards as in the case of this ship.

Great Britain had at an early date begun to develop screw propulsion, and was building ships and engines of the best character, and introducing them in their ocean commerce and in their navy, which resulted in their paramount influence in ocean commerce of that country. It practically began with the advent of the fine screw ship, the *Great Britain,* in 1844.

While Great Britain was engaged in the establishment of its future pre-eminence, the great commercial city of New York adhered to the paddle-wheel, with its walking-beam engine, that led to our ultimate elimination from the world's commerce.

While the decline of our foreign commerce incident to the prolonged use of the paddle-wheel became a conspicuous feature in the East, it did not destroy our coastwise business, which extended from the East to the Pacific Coast. The business with the cities there, New York and San Francisco was still in the hands of shipping companies of New York, and many small paddle-wheel steamers were still built, but much of the local trade and travel in the Pacific was done in small iron vessels, many of which were screws and built on the Delaware. When the large paddle-wheelers were worn out or lost, they were not renewed. The propellers were generally of Captain Loper's patent, and his name became as much talked of as Ericsson's was previously, particularly as the propeller was much better.

No. 2—The Effect of Parallel Middle Body Upon Resistance.

BY D. W. TAYLOR, NAVAL CONSTRUCTOR, U. S. N.

ABSTRACT.

A portion of the work of the United States model basin during the past year consisted of an investigation into the effect upon resistance of full vessels of varying percentages of parallel middle body. This question arises at times in dealing with full vessels of moderate or low speed, and it appeared desirable to determine whether there was, from the point of view of resistance, an optimum length of parallel middle body in a given case. There are, of course, a number of factors

entering into the matter in the case of a design, but resistance alone is considered in this paper.

The lines of the parent form from which all the models tested in this connection were derived represent a model having a 'midship-section coefficient of .96, a ratio of beam to draft of 2.5, and a longitudinal (prismatic) coefficient of .68. All the models tested had the same 'midship-section coefficient and ratio of beam to draft, variations being in longitudinal coefficient, in size and in shape of curves of sectional area.

There were three series of models tested, each series containing twenty models. Four sizes of models were used in each series, and for each size of model five curves of sectional area were used. The longitudinal coefficients used were .68, .74 and .80. For the .68 longitudinal coefficients the five percentages of parallel middle body were 0, 9, 18, 27 and 36. For the longitudinal coefficients of .74 these percentages were 0, 12, 24, 36 and 48. For the longitudinal coefficients of .80 the percentages were 0, 15, 30, 45 and 60. The displacements used for the 20-foot models in fresh water were 1,000 pounds, 1,500 pounds, 2,250 pounds, and 3,000 pounds. This range covers the majority of vessels.

Displacement remaining unchanged, the greater the percentage of parallel middle body the finer the ends.

Resistance being due partly to the friction of wetted surface and partly to wave making, etc., constituting the residuary resistance, it is naturally considered under these two heads.

The larger models have a little more wetted surface, as would naturally be expected, owing to the greater obliquity of their waterlines. The difference, however, is slight. The variation with percent of parallel middle body is also very slight.

Practicable variations in the length of parallel middle body in a given case will have hardly any effect upon wetted surface or skin resistance. It should be remembered in this connection that skin resistance is always the major factor of the total resistance for vessels of the kind now under consideration. As a general thing for such vessels when well designed the skin resistance is in the neighborhood of 70 percent of the total.

Considering now the residuary resistance the conditions are very different, and we find this element of the resistance materially affected by the percentage of parallel middle body.

At the very high speeds any parallel middle body is prejudicial to speed. While vessels of full type are not pushed to high speeds, it may be remarked that the high residuary resistance associated with the fine ends at the high speeds is in agreement with a number of other experiments made at the model basin, which indicate that for very high speeds full ends are favorable to speed rather than the reverse. For moderate speeds, however, below a speed-length ratio of unity, full ends are usually distinctly prejudicial to speed.

For practicable speeds for full ships, say below a speed-length ratio of .9, the experimental results indicate an optimum length of parallel middle body, the greatest residuary resistance corresponds to 48 percent of parallel middle body, but the next corresponds to 0 percent, the minimum residuary resistance evidently corresponding to some length of parallel middle body between 0 and 48.

From a series of diagrams, showing contours of residuary resistance in pounds per ton, plotted upon percentages of parallel middle body as abscissæ, and values of displacement-length coefficient as ordinates, it is shown that for a speed-length coefficient of .55, the minimum residuary resistance is almost independent of the displacement-length coefficient, corresponding very closely to 25 percent length of parallel middle body regardless of the displacement-length coefficient. For higher speeds, there is more variation in the value of minimum residuary resistance as we vary displacement-length coefficient, but the variation in length of parallel middle body corresponding to minimum residuary resistance is not great, so we can very reasonably consider the actual minimum residuary resistance between displacement-length coefficients of 100 and 150 as practically constant. Hence we are enabled to almost eliminate the effect of displacement-length coefficient.

Curves plotted upon values of speed-length coefficient showing (1) the minimum residuary resistance; (2) the percentage of parallel middle body corresponding to the minimum resistance; (3) the resistance 10 percent above the minimum; (4) percentages of parallel middle body above and below the minimum for which the residuary resistance is 10 percent above the minimum, indicate the boundaries within which length of parallel middle body may be varied without appreciable effect upon resistance. Thus, if the residuary resistance is about 30 percent of the whole, it may be increased 10 percent with an increase of but 3 percent in the whole resistance. The upper limit is naturally the more important, and the experiments indicate that if the lengths of parallel middle body given by the curves fixing the upper limits are much exceeded, there is material increase of residuary resistance.

Broadly speaking, from the point of view of resistance alone, for the range of speeds attained in practice by full vessels, the optimum length of parallel middle body is for longitudinal coefficient of .68 from 12 to 16 percent, but it may be made 25 percent without material increase in resistance. For a longitudinal coefficient of .74 the optimum length of parallel middle body is from 24 to 27 percent, but it may be made from 36 to 40 percent without material increase of resistance. For a longitudinal coefficient of .80 the optimum length of parallel middle body is from 32 to 35 percent, but it may be made from 44 to 48 percent without material increase of resistance.

These conclusions apply to values of speed-length coefficient above .50. For very low-speed vessels the residuary resistance is such a small percentage of the total that the limits above may evidently be materially exceeded.

No. 3.—The Influence of the Position of the Midship Section upon the Resistance of Some Forms of Vessels.

BY PROFESSOR H. C. SADLER.

ARSTRACT.

In the following experiments the term "midship section" designates the section of maximum area. Two sets of models of ordinary form were tried, and in each series the length, breadth, draft, displacement, sections and curve of sectional areas were kept constant, the only variation in the form being that due to expanding or contracting the forward and after body, due to placing the midship section at various positions in the length. When the midship section is at the center of the length, the curves of sectional areas in both models were the same for both forward and after bodies:

PARTICULARS OF MODELS.

Model.	$\frac{L}{B}$	$\frac{B}{d}$	$\frac{L}{d}$	Coefficients.		
				Block.	Prism.	Mid. Sect.
A	8	2.143	17.14	.503	.538	.935
B	8	2.143	17.14	.567	.606	.936

In each case the midship section was placed in four positions: (1) At the center of the length; (2) at 5 percent of the length aft of the center; (3) at 10 percent aft, and (4) at 10 percent forward of the center.

At low speeds the position of the midship section has little or no influence upon the resistance, but as the speed increases there is a certain position for each speed where the resistance is a minimum. This position travels aft as the speed increases. With the midship section 10 percent aft or 10 percent forward of the middle of the length; the resistance shows a marked increase at the higher speeds.

The curves for model B follow in the same general lines as those for model A. In this case, however, as the model is of somewhat fuller form, the minimum occurs at a slightly different place, and the effect of the position of the midship section is noticeable at a smaller speed-length ratio.

In both models, when the midship section was placed at 10 percent of the length aft of the center, the flow around the after body seemed somewhat disturbed. This was doubtless due to the hollow form caused by the closing up of the sections, and the performance in this particular case could doubtless be improved by filling out the after body at the stern and easing the form immediately aft of the midship section. Such modifications, however, would destroy the main object of the above investigations, which show the effect of the position of the midship section only, everything else remaining constant.

No. 4.—Some Ship-shaped Stream Forms.

BY ASSISTANT NAVAL CONSTRUCTOR WILLIAM M'ENTEE, U. S. N.

ABSTRACT

The investigation on which these notes are based had for its principal object the determination of the variation of velocity of water when constrained to move in a plane along a form of the shape of a ship's waterline, or, more properly, waterplane.

The main conclusions from the investigation are: (1) That hollow waterlines cause less wave-making disturbance than straight or convex waterlines, and (2) that, as the hollowness and fineness of waterlines are increased, the wave-making disturbance decreases to a minimum, after which, if the lines are made still finer and hollower, the wave-making disturbance again increases.

These conclusions result from an investigation which, to extend to actual ships, requires assumptions which seem reasonable, but for which no rigorous proof is given.

It was early seen that previous investigations of the subject dealt with stream forms, which had points of variance from those which appeared to be of most interest. The variation was due to using sink and source functions of such form that the resulting stream forms were (1) blunt or rounded at the entrance point, (2) the entrance was convex and neither straight nor hollow. The principal difficulty with such forms is that, no matter how fine they are made, the pressure at the entrance point is always that due to the velocity-head of the speed of advance, a condition which prevents comparison of the probable wave-making effect of waterline of varying sharpness of entrance and varying waterline coefficients.

Since waves about a ship are due to variations in pressure head in the water around it, it seems obvious that the greater such variations the greater will be the wave disturbance, and as the pressure head depends on the velocity, it appears that the conclusion to be drawn from the above comparison, in which the form which has the hollowest lines and smallest waterline coefficient has the greatest velocity variation along it, is that the waterline coefficient may be made too small and the waterline too fine and hollow. The bow wave may be smaller, but the depression amidships is greater and the total wave-making result may also be greater.

Probably the most interesting conclusion from the investigation is the desirability of using hollow waterlines to reduce wave-making. It can be shown that if a stream form has a straight or convex line at the entrance, the pressure head will be a maximum and equal to that due to the velocity through the water. The total variation of velocity along such a stream form will be more than 100 percent.

No. 5—Applications of Electricity to Propulsion of Naval Vessels.

BY W. L. R. EMMET.

(This paper is published in full on page 469.)

No. 6.—The Producer-Gas Boat Marenging.

BY H. L. ALDRICH.

ABSTRACT.

This paper describes in detail the arrangement and performance of the 40-foot cruising motor boat *Marenging,* equipped with a heavy-duty, four-cylinder, four-cycle engine operating on producer gas. The substance of the paper will be found on pages 110 and 111 of the March, 1909, and page 313 of the August, 1909, issues of INTERNATIONAL MARINE ENGINEERING. As the result of his experience with this boat, Mr. Aldrich states that, as compared with gasoline (petrol), it costs scarcely one-tenth as much to use producer gas, and as compared with steam, probably from one-third to one-half as much.

No. 7—Building and Equipping the Non-Magnetic Auxiliary Yacht Carnegie with Producer-Gas Propelling Equipment.

BY WALLACE DOWNEY.

ABSTRACT.

This paper describes briefly the construction of the hull and machinery of the 568-ton auxiliary yacht *Carnegie,* built entirely of non-magnetic materials for the Carnegie Institution in Washington, to be used in making a survey of the magnetic variations at sea. The yacht has a brigantine rig, and is specially fitted for taking magnetic observations. The auxiliary propelling machinery consists of a 150-horsepower gas producer and engine, built entirely of non-magnetic materials. A complete description of this vessel, covering the substance of this paper, was published on page 47 of the February, 1909, issue of INTERNATIONAL MARINE ENGINEERING.

PAPERS READ NOVEMBER 19.

No. 8—The Design of Submarines.

BY MARLEY F. HAY.

ABSTRACT.

All submarines are fundamentally alike, the greater part of the given reserve buoyancy being neutralized by the addition of water to a main tank, an auxiliary tank being provided to compensate for different weights and the difference of salinity in the sea water. Beyond this point, however, submarines differ according to the judgment of the designer, the main factor which seems to be responsible for all the divergence of ideas being the safety factor.

Submarines may be divided into two classes, the double-hull and single-hull. In double-hull submarines, the outer hull is designed on torpedo boat lines, in order to develop a high surface speed. As this shape of hull is incapable of sustaining the pressure due to great depth, an inner hull is fitted for strength. In boats of this type the depth to which the boat may safely go is less than in the case of single-hull vessels, the maximum for a Krupp or Laurenti boat being 43 meters, while a single-hull boat of the Holland type has been submerged to 70 meters, and is capable of submergence to 100 meters. On account of

the additional weight of the double-hull vessel its factor of safety in a vertical plane is low, and an attempt to increase this factor is usually made by fitting a drop keel. The necessity for a safety keel is not so urgent in a single-hull vessel, and water ballast which can be blown out by compressed air is substituted.

Coming to the question of stability and seaworthiness in the double-hull vessel, the center of gravity of hull and machinery weights is above the center of buoyancy when the ship is at the surface. Therefore, when being submerged the center of buoyancy rises and the center of gravity drops, there being a critical point where they coincide, and the stability of the vessel must depend entirely on its form. In single-hull vessels the center of gravity is always below the center of buoyancy. Due to the considerable metacentric height of the double-hull vessels, the rolling period is very short, and the angle of heel is liable to become excessive, whereas in the single-hull vessel the rolling period is lengthened, stiffness is much decreased, and, in fact, the rolling is practically replaced by a curious lateral translation of the entire ship.

Double-hull vessels can be constructed with large percentages of reserve buoyancy by making the superstructure watertight.

It was formerly considered that submergence could be carried out in two ways. First, by submerging on an even keel by means of double rudders, or hydroplanes, forward and aft, and, second, by inclining the axis of the boat downwards by means of a single diving rudder at the stern. As a matter of fact, the hydroplane system acts in the same manner as the single diving rudder, and this difference really no longer exists.

Although double-hull vessels show high surface speed, yet the weight of the accumulator battery is so cut down that the submerged speed is relatively low and the radius of action when submerged comparatively short. Single-hull vessels are capable of higher submerged speeds. Which of these qualities is desirable, however, depends upon tactical considerations. As a rule, single-hull vessels maneuver more easily.

The tendency of future submarine design will be towards vessels of higher surface speed for which a single-hull vessel can undoubtedly be designed, the adoption of heavy oil engines to increase the safety of fuel storage and, possibly, the development of an internal-combustion engine, running on a closed cycle, which can be used when the boat is submerged, therefore, eliminating the accumulator battery weights.

No. 9—The Foreign Trade Merchant Marine of the United States. Can it be Revived?

BY G. W. DICKIE.

ABSTRACT.

A careful study of the early history of the foreign trade shipping of the United States will show that the foreign shipping trade of this country never prospered even in the days of wooden ships without substantial protection, and this is due to the fact that every nation which aspires to maritime power has been willing to pay for it.

In 1789, when protection began, the foreign trade shipping of the United States amounted to only 123,893 tons, including both exports and imports carried in American bottoms, and forming but 17½ percent of the imports and 30 percent of the exports. In ten years this had increased to 657,142 tons, forming 90 percent of the imports and 87 percent of the exports. During the war of 1812 the figures fell to 71 percent of the imports and 51 percent of the exports! Under the original navigation laws, in 1825 the United States carried in her own ships 95.2 percent of her imports and 89.6 percent of her exports, and this is the highest point reached by American shipping in foreign trade.

Many think that the navigation laws which were formerly so effective would again give to the United States her fair share in foreign trade. While this is doubtless true, there is grave doubt as to the possibility of maintaining under such laws pleasant relationship with other nations who are doing business on the ocean.

It is unnecessary to describe the existing conditions as far as the merchant marine in foreign trade is concerned. About 93 percent of our foreign commerce is being carried in foreign ships under foreign flags. Contrary to the general impression, the decline of our foreign shipping trade during and since the Civil War was not due primarily to the war; on the contrary, the steady decline began from the time (1812) that the foreign-carrying trade of the country was opened free to foreign ships, when the final restrictions on competition by all countries in our foreign trade were removed.

In addition to the laws of protection to American shipping in the foreign trade, other forces have hastened its decline. One of these was the change from wood to iron, and then steel, in the construction of ships, and the substitution of steamships for sailing vessels.

When this country once realizes that the time has come when it is a national necessity that merchant ships built in our own shipyards, officered and, if possible, manned by our own citizens, owned and operated by our progressive men of affairs, shall represent our enterprise and power in all parts of the world, there will be found a way to do it with profit to all concerned. Efforts to stimulate shipping will then be understood by the people, and questions regarding such matters and needing legislation will be treated in the manner that their importance demands. Admitting to register foreign-built ships, as now proposed in a measure before Congress, will not revive the shipping of this country; if it would the shipbuilder might be willing to be sacrificed in order that such a result might follow. A country that could not build ships has never, as far as I have been able to find, been able to own and operate them.

The necessity of doing our own foreign-carrying trade is fast growing. Under present conditions the value of our exports in round figures is $1,750,000,000 (£360,000,000), and of our imports, $1,250,000,000 (£256,600,000). About $250,000,000 (£51,300,000) are paid annually to foreign ship owners to carry on this commerce.

There are reasons why the American ship cannot compete with the foreign ship in the ocean-carrying trade. National conditions over which our shipbuilders or shipowners have no control, and which they are powerless to change, make the cost of building vessels in the United States from 30 to 40 percent greater than in other countries. The cost of manning and victualing these American ships is also much greater, probably not less than 30 percent more than manning and victualing foreign ships. In addition there are other expenses in the operation of vessels which are greater in the United States than they are in other countries, such as taxes, repairs outfit and equipment. Most of these higher costs are the outgrowth of conditions resulting from the policy of high protection to industries that have been developed under laws first enacted, strange as it may seem, by the very Congress that removed all protection from shipping engaged in the foreign trade, and which policy has continued through all the period that American shipping engaged in the foreign trade has been declining.

Other nations are paying approximately the following amounts for the stimulation of their foreign trade: Great Britain, including Admiralty subventions, $7,000,000 (£1,440,000); France, including bounties on construction and

navigation, about \$9,500,000 (£1,950,000); Germany, for mail service, \$3,000,000 (£616,000); Russia in postal regulations, \$2,000,000 (£411,000); Japan, in subventions, \$6,200,000 (£1,-273,000); Italy, in subventions, \$2,700,000 (£554,000); while the United States pays only for the carriage of her mails, about \$1,600,000 (£329,000).

Due to the withdrawal, in 1907, of the Oceanic Steamship Company, of San Francisco, of its line to Australia, the American flag has vanished from the commercial routes of the South Pacific.

A most potent argument in favor of the upbuilding of the merchant marine, and one which has had great weight in influencing Japan in this respect, is the use of such a fleet as an auxiliary to the navy. At present the navy is forced to employ foreign vessels to keep it supplied with fuel and other necessities when it leaves our own shores.

I do not believe that we should follow the French method; ships can be put on the ocean and navigated from one port to another if their expenses are paid, but this nursing is without any sound economic policy to back it up; I believe it gives no ultimate benefit to the commerce of the nation adopting it.

In my belief the first duty of the United States is to establish, by mail subventions, permanent lines of communication between her ports and the principal ports of the world, especially those where our products would be most likely to find a permanent market. The character of the service should be clearly stated, and bids for the service required should be asked from responsible shipowners and awards made to the lowest responsible bidder.

Compared to what we annually expend on our navy the expense of such a fleet of merchant auxiliaries would be small. These lines would build up a commerce for this country worth many times what it would cost to maintain them. The method of letting out the subsidies, as it were, to the lowest bidder would secure the required service at the lowest feasible figure, and would be fair to all concerned.

No. 10—Material Handling Equipments for Lake Vessels.

BY RICHARD B. SHERIDAN.

Iron ore was first discovered in the Lake Superior country in 1844, but on account of its location and the almost insurmountable difficulties of handling and transportation, it was nearly twenty years before the ore of this district could be commercially worked.

In 1855 the Government completed its first system of locks at Sault Saint Marie, and the first cargo of ore (114 tons) was carried down the lakes from the mining district. The entire shipments for the year amounted to 1,449 tons, and it was not until 1873 that a season's shipment amounted to more than 1,000,000 tons. In 1907 it reached a maximum of over 42,-000,0000.

In the development of this traffic the first step was the construction, in 1860, of a loading dock at Marquette. This dock has been the model on which all of the great ore docks of the Northwest have been built. It consisted of a long line of pockets on a dock extending out into the lake, and arranged so that boats could be brought alongside for loading. The material was brought over the pockets on railway cars, arranged so as to be dumped into the same. Each pocket was equipped with spouts and gates, and of such height as to permit of a slope to the chute, so that the material would run out by gravity. Records are given in which boats of over 10,000 tons capacity have been loaded in as short a time as one hour at modern docks of this type.

The question of loading has not, however, been the perplexing factor in the development of the lake traffic. The great and all-important difficulty that had to be met and overcome was the question of dispatch in the unloading of boats in the lower lake ports. In 1879 a machine was constructed in the harbor of Cleveland, but it had so many faults that it could hardly have been called a success, and it was not until 1880 that the first successful unloading machine was developed, and this date marks the beginning of the real and speedy development of material-handling machinery as well as the improvements in the ship construction of the Great Lakes.

This first device was a cableway machine, built and erected at Cleveland, Ohio, in 1880, under Mr. Alex. E. Brown's supervision, and with its introduction came the formation of the Brown Hoisting & Machinery Company.

This type of machine was an infinite improvement over the old methods, but it had one fault, and that was, that it could only cover a limited storage pile. The next machines were improved upon, and instead of using the cable type, a structural span bridge of 180 feet in length was employed, and both its supporting piers were mounted on wheels, so that the machine could be moved along the full length of the dock.

Machines of this type came immediately into universal use, and nearly every unloading dock was equipped within a few years.

The problem of reducing the hand labor in the boats became an important factor, and, for several years before the grab-bucket was adopted, attempts were made to work mechanical buckets in coal and similar soft materials. About nine years ago the first successful grab-bucket equipment was erected in Chicago by the Hoover & Mason Company.

In the development of the grab-buckets the old principle which the grabs or clamshells employed for so many years in the handling of dirt and other material has been followed out, and consequently the digging power of the bucket depends to a very large extent upon the weight of the bucket itself, and to get a load it is always conceded that the bucket must be dropped as hard as possible to get an entrance into the material.

The design and principle of working of the Brown bucket are novel. On acount of the motion of the digging blades on most buckets, weight, as mentioned above, plays a very important part in how good a digger the bucket is, but in the bucket I refer to a new principle is brought into play. The blades of the Brown buckets, when open, stand almost in a vertical position, and when closing they retain this vertical position for nearly one-half of their stroke, and their action during this time on the material is one of scraping. By the time they have moved through half of their total stroke they have gathered or scraped together a pile of material between them, and at this point the motion of the blades changes to one of rotation, so that they close under the pile of material gathered together. The bucket is so proportioned that the pile which is gathered equals approximately the capacity of the bucket. This grab, also, by its construction is admirably suited for handling lumpy material, inasmuch as the side plates forming the blades of the bucket are cut away at such an angle that the same is past the angle of friction, so that any material getting in front of the edges of these side plates will not cause the bucket to slide over them, but must, by virtue of the angle of these edges, be pushed ahead or to one side. I believe that this feature of the Brown bucket is not found in any other make.

With the adoption of the grab-bucket came still another change in the general design of unloading machinery. Practically no men were needed in the boat for successful operation, and the hoisting and operating mechanism on the machine was all installed on the moving trolley, and this type of trolley has (as is generally known) become to-day to be recognized as the most efficient and rapid.

With the introduction of the grab-bucket there have been practically but two types of machines developed: One, that employing a bucket suspended by the operating ropes, and the other, a grab-bucket carried on a rigid arm. I will not at-

tempt to discuss the merits from my standpoint of the rigid-arm or "stiff-leg" machine over the suspended bucket type, but will add that they have become a popular machine along the lake districts.

The outcome of operating buckets of this character was that several of the big shipbuilding companies developed a line of boats built especially for the ore traffic, with hatches spaced about 12 feet centers, and clear holds.

The coal trade is by no means a small factor in the total amount of material handled on the Great Lakes during the season. The coal-unloading machines have all passed through the same lines of development that the ore plants have, and, as may be readily supposed, the grab-bucket is as universally used in the handling of coal cargoes as it is in the iron ore traffic. The type of machines employed is very similar to that used for the handling of iron ore, and is designed to handle grabs having a capacity generally of about 2 tons of coal. The question of loading coal into vessels has received during the past ten years considerable attention. A large percentage of the coal which is loaded into boats is handled either by car-dump machines or from elevated docks of the same type as those used in the handling of iron ore.

No. 11—Structural Rules for Ships.

BY JAMES DONALD.

This paper is too voluminous to admit of even an abstract within the limits of this report. It contains a complete set of new rules for the construction and classification of ships which the United States Standard Association originally attempted to compile. Before the completion of the work, however, the United States Standard Association was incorporated with the American Bureau of Shipping, so that the new rules were unnecessary. In order, however, that these new rules, upon which a great deal of work had been expended, should not be lost, and that no results should accrue, it was deemed advisable by the writer to present the rules before the society, in order that all those interested in shipping and shipbuilding might have an opportunity to express their opinion upon them. Nothing new is claimed for these rules. The idea has been to arrange what has been found by experience to be the best practice, and what has already been done, in such a manner that it can be easily understood and the design arrived at quickly and easily.

No. 12—Rivets in Tension.

BY ROBERT CURR.

ABSTRACT.

In investigating the value of rivets under tension the author has been unable to find any authority on same. Structural engineers give no value for rivets under tension, and substitute bolts in all cases where tension is met with. On the Great Lakes, rivets in tension are simply considered on the point of shearing the same. The value of a rivet is taken to be equal to the punched materials.

A plan of a 3-foot frame space showing the main frame and web frame as well as the longitudinals and intercostals of a typical Lake cargo vessel is shown, on which are indicated the numerous points where the construction depends for strength upon rivets in tension. The whole object in the case of the web frame is to make a belt of same, and have it throughout in strength equal to its weakest part through a line of rivet holes spaced eight diameters across same; but since there are numerous connections which depend for their strength upon rivets in tension, the value of which are unknown, or at best doubtful, it is evident that the full value of the materials, as placed, is not obtained.

The author concludes that if rivets in tension have no value some other mode of construction is necessary in order to get the value of materials placed in vessels.

No. 13—Strength of Water-Tight Bulkheads.

BY PROF. WILLIAM HOVGAARD.

ABSTRACT

It cannot be said that we have yet reached a satisfactory solution of the problem of the strength of bulkheads. The most striking evidence of this is perhaps the loss of the White Star liner *Republic*, which, according to various accounts, was due ultimately to leakage and breakdown of the bulkheads.

The dimensions of this class of vessels have increased enormously of recent years, and therewith bulkheads have become larger and deeper. It seems, therefore, not unlikely that the rules of the classification societies, which were framed some years ago, may now need a revision in case of larger ships.

In the present paper it is proposed to deal only with the theoretical treatment of the subject. As the theory of the strength of *bulkhead plating* has already, as far as it is developed, been fully dealt with, it is the particular object of the present paper to deal with the strength of *bulkhead stiffeners.*

It is proposed to deal with the simple case of a rectangular bulkhead, stiffened by a set of parallel, equidistant stiffeners of equal and uniform strength. This is indeed the only case which can be solved theoretically, and that only under certain assumptions, which conform more or less imperfectly to actually existing conditions.

The first chapter of the paper deals with the determination of deflection and stresses for simple bending and shearing, while the tension, which may exist in the stiffener as a whole, is neglected.

In the problems dealt with in Chapter II. is included the tension, which exists in a stiffener fixed at the ends to immovable supports in such a way that the ends are prevented from sliding relative to the supports.

The first problem considered in the first chapter is that of a stiffener supported only at the ends, and four cases are considered: (1) The stiffener is free to turn at both ends. (2) The stiffener, by means of brackets, is fixed with both ends vertical. (3) The stiffener is bracketed only at the foot. (4) The stiffener is bracketed only at the top.

Where both ends are free to slide, the maximum bending moments, and hence the maximum stresses, will be smallest when both ends of the stiffeners are bracketed. When the stiffener is bracketed at the foot only the maximum bending moments will be greatest, greater even than if no brackets had been used, and considerably greater than if bracketed at the top only. That bracketing at the foot only is disadvantageous is probably not generally realized.

The second case considered is with the stiffener supported at both ends and at one intermediate point. Three cases are dealt with: (1) When the stiffener is freely supported at all three points. (2) When it is fixed vertically at the ends. (3) When it is fixed vertically at all three points.

There is considerable advantage in preserving the continuity of a stiffener over a point of support placed at the middle, except where brackets are used both at the middle and at the ends, in which case it is immaterial whether the stiffener is cut or not.

Bracketing of a continuous stiffener is of advantage by uniform load, but it is only necessary to bracket the ends. Thus, for instance, a deck beam supported by a stanchion at the middle should always be well bracketed at the ends.

With uniform plus increasing load there is little or no advantage in bracketing. Thus it appears that, as far as bending is concerned, a vertical bulkhead stiffener, supported at a point near the middle may as well be left entirely unbracketed; but here, again, it must not be overlooked that the brackets may be useful in enabling the stiffener to work by tension and in relieving the boundary connections of the bulkhead.

If the stiffener is broken at the middle point of support, it is practically indifferent whether it is bracketed at the ends or not, unless it is also bracketed both above and below the middle point, in which case there is a considerable gain.

In the second part of the paper two methods are given for determining the strength of bulkhead stiffeners, where tension is considered, in the case of stiffeners efficiently connected at head and heel to fairly immovable supports, and where the deflection is great.

The first method, which is applicable only to uniform load and to a stiffener attached at both ends to immovable supports, free to turn at these supports as if on hinges, consists of finding an expression for the maximum deflection in terms of the pressure which would produce this deflection in an elastic stiffener freely supported at the ends and with no tension along the neutral axis. The maximum deflection is then expressed in terms of the pressure which would produce this same deflection in a perfectly flexible stiffener hinged at the ends. Equating the two expressions for the deflection, a relation between the two pressures is obtained, and assuming that the sum of the two pressures is equal to the total pressure of the water, which is a known quantity, the unknown pressures can be determined.

The second method deals with a formula which takes account not only of the forces acting normally to the stiffener but also of the tension acting along the neutral axis. This formula is a differential equation of the second order, and the solution for it is based on an expansion of the exponential functions in a converging series. When the stiffener is free to turn at the ends, this method does not lead to a practicable result. When the stiffener is fixed vertically at both ends, however, there is no difficulty, and this case is dealt with both for a uniform load and for a combined uniform and increasing load.

No. 14—The Development of the Gasoline (Petrol) Power Boat.

BY E. T. KEYSER.

ABSTRACT.

Early gasoline (petrol) power boats were similar in design to their forerunner, the naphtha launch. The engine was usually placed as far back in the hull as possible, necessitating considerable rake to the shaft, which, together with the squat of the fan-tail stern, kept the boat down to a very moderate speed. Gradually the position of the engines was moved to the center of the boat, decreasing the rake of the shaft and giving a better disposition of weights, and the compromise and torpedo sterns were developed.

The clipper-bowed, fan-tail stern, high-cabined, glass, windowed launch gave way to the trunk-cabin power cruiser, and this in turn to a large extent to the raised-deck boat, and, in larger sizes, to the bridge-decked cruiser. Finally, the steam yacht field was invaded, until to-day the internal combustion engine is the accepted method of power for craft of less than 100 feet over all.

To show the advantage of the gasoline (petrol) engine in the economy of space, small engine-room force, crew's quarters, etc., the author describes in detail an 83-foot cruiser of the compromise stern type, with engines and gasoline (petrol) tanks installed amidships. This boat is not only a concrete example of the comfort, but of the actual luxury, which may be found to-day in a properly-designed motor boat capable of going almost anywhere to the extent of her fuel capacity, and yet which may be run much more economically than a steam yacht affording anything like the same accommodations.

No. 15—A System of Mathematical Lines for Ships.

BY JAMES N. WARRINGTON.

ABSTRACT

A workable system of mathematical lines for ship-shaped bodies should be capable of producing fairness of form, and at the same time should permit a very considerable degree of freedom in design. Fairness may be attained automatically by the forms of the equations, while freedom in design will depend upon the number of optional constants. In the use of equations the mental process of designing consists largely of thinking in constants, and in order that this may be done with a satisfactory degree of perspicacity the constants should have a recognizable significance, each standing for some definite quality of its curve. As the constants are increased in number, thus giving increased freedom in design, they become involved in each other and lose distinctiveness, and the geometrical conception becomes obscure. Facility of interpretation, therefore, is favored by constants few in number and of easily perceived geometrical effect.

In harmony with this view the author deduces equations which permit no more than what is deemed a necessary degree of freedom in design, and the optional constants possess a sufficiently clear definition to permit of ready interpretation.

Equations are given for computing the area ratio R_a, from which the area of any section can be obtained by multiplying R_a by the area of the greatest section, also for computing the breadth ratio R_b of the load water-line, whence the half-breadth of the load waterline at any station can be obtained in absolute terms by multiplying the greatest half-breadth by R_b. Equations are also given for computing sectional coefficients and ordinates of the sections.

The labor of computation is considerable, but each design worked out is applicable to ships of the same type without regard to size or proportion, for the reason that the ordinates are in ratio form.

THE MARINE POLAR MOTOR.

BY HUGO ANDERSON.

The marine polar motor is a direct reversible Diesel motor and involves the same characteristic process of combustion as the ordinary type of Diesel motor. The main idea of the system is to couple to a propelling motor a maneuvering motor into which air under pressure is admitted when maneuvering, but which simultaneously and continually serves as a blowing-out pump for the propelling motor which works on the two-cycle system.

The arrangement of the motor is diagrammatically shown in Fig. 1, where 1 represents four (or two) combustion cylinders working on the two-cycle system, and 2 represents two double-acting maneuvering cylinders with cranks at right angles. When propelling, atmospheric air is sucked into the maneuvering motor through pipe 5. Here the air is compressed to a low pressure and exhausted through pipe 6 into the working cylinders. In these cylinders the air is compressed to 529-558 pounds. The products of combustion are exhausted through the silencer into the air.

When starting, the maneuvering motor is cut off from the atmospheric air and put in communication with the air receiver 9. The air consumed when maneuvering is automatically made up by the air pump 8, which is put in action when the pressure in the receiver has fallen below a certain value.

The fuel oil from the tank 14 is led through the filter 15 to the pumps 16, which force the oil into the fuel valves 13. From the valves the oil is forced into the combustion chamber by air under pressure supplied by the air pump 11. A receiver and pressure adjuster is shown at 12. The thrust-block 4 is made separately from the motor, and astern of the fly-wheel is a flange coupling.

A complete installation includes also a water pump for cooling the cylinders, etc., for which salt water can be used.

The operation of the maneuvering motor is shown in Fig.

2. The circle, Fig. 2, represents the motion of a crank pin of a maneuvering cylinder. The inlet valve opens at point 1, immediately after the upper dead center, and the admission of air is cut off at point 2, which corresponds to the line *A-B* in the indicator diagram. From 2 to 3 there is a slight falling off in pressure (*B-C*), which is leveled at 3, the long piston uncovering an aperture in the cylinder jacket communicating with the air. As a matter of fact all air is admitted to the motor through a single pipe 7, but for the sake of clearness two pipes 5 and 7 are shown in the diagram. The piston having passed the lower dead center, the pin being then at 4, the aperture in the cylinder jacket is closed. The air is compressed (*D-F*) and afterwards forced into the receiver 6. When maneuvering, the atmospheric air is cut off and air under pressure is admitted from 1 to 2. The indicator card is then H, I, J, D, E, D, F, G.

The characteristic feature of this working arrangement is, that the starting and the combustion take place in the motor *simultaneously,* whereby the transition period is avoided and a quicker maneuver is obtained, as the double moment, or more, is at hand when starting.

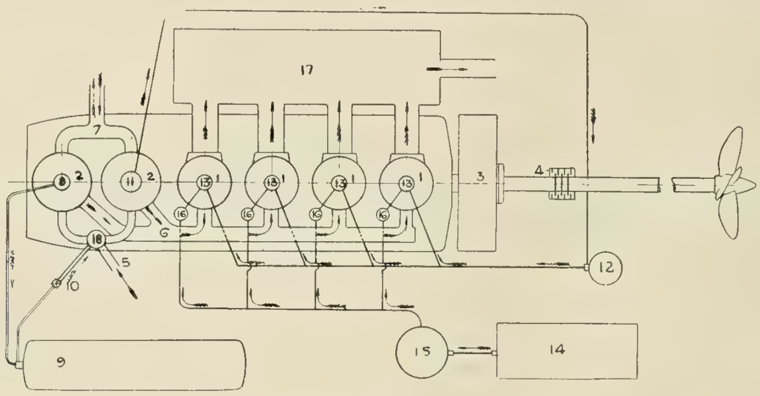


FIG. 1.

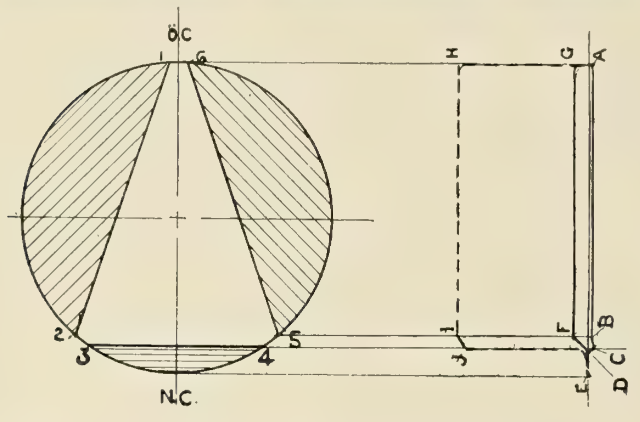


FIG. 2.

A few indicator cards are shown in Fig. 3. *A* is a card from a working cylinder, and it has the same appearance as a card from the ordinary Diesel motor, with the exception of the exhaust line, characteristic of the two-cycle system. *B* is a starting card from the maneuvering cylinder. There are three admission lines, and as many lines representing the air supply to the receiver 6. The highest pressure is 74 pounds. *C* is a card from the maneuvering cylinder when the motor is propelling and taken with a more flexible spring, and finally *D* is a card from the receiver.

As mentioned, one of the regulating parts of the maneuvering cylinders consists of an aperture in the cylinder jacket, uncovered by the piston. This arrangement necessitates the pistons being made very long, a fact which is utilized by disposing air pumps in the interior of the long pistons, special levers for these pumps being in this way saved. Moreover, the pistons are lengthened downwards to form cross-heads.

The operation of the propelling cylinders is seen in Fig. 4; 26 is the receiver, kept under a pressure of about 221 pounds by the maneuvering cylinders; 41 is the washing-out opening, and 42 the exhaust opening; 25 is the fuel valve, the only part of the combustion cylinder that is governed. The valve is regulated in the ordinary way by a cam disc.

The fuel valve is of unique construction, and in particular the carburetor is carefully studied. Thus the same quality of fuel enters the cylinder for large as for small charges, and all the fuel injected by the fuel pump during one stroke enters during the admission period immediately following.

As a result of the special construction of the fuel pump, and of the co-operation between the pump and the fuel valve, and finally of the design of the fuel valve, and specially that of the carburetor, reversal of the motor is accomplished without putting the reversing lever on stop, and also the reversal is accomplished at any speed without risk of damaging or ruining the motor from back explosions and the like.

The reversing of the motor is achieved by altering the position of the fuel pumps and the fuel valves, and this by displacing the cams. To change from ahead to astern, the reversing lever is put in the astern position, at which the fuel pumps are uncoupled first, and then the fuel valves, after the latest delivered fuel charge has been injected and burned in the cylinders. Thereupon the admission of air under pressure in the maneuvering motor is opened. The maneuvering motor is now acting as a pump until the force of the fly-wheel is consumed. When the engine has stopped the maneuvering motor starts to act as a motor and to turn the engine astern. As soon as the engine has started the fuel pumps work again and immediately the ordinary working cycle recommences in the combustion cylinders. There are, then, two turning moments accelerating the fly-wheel, viz., the moment of air under pressure and the moment of combustion. This explains the rapidity of maneuvering.

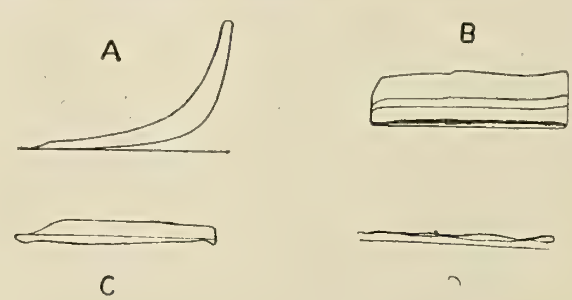


FIG. 3.

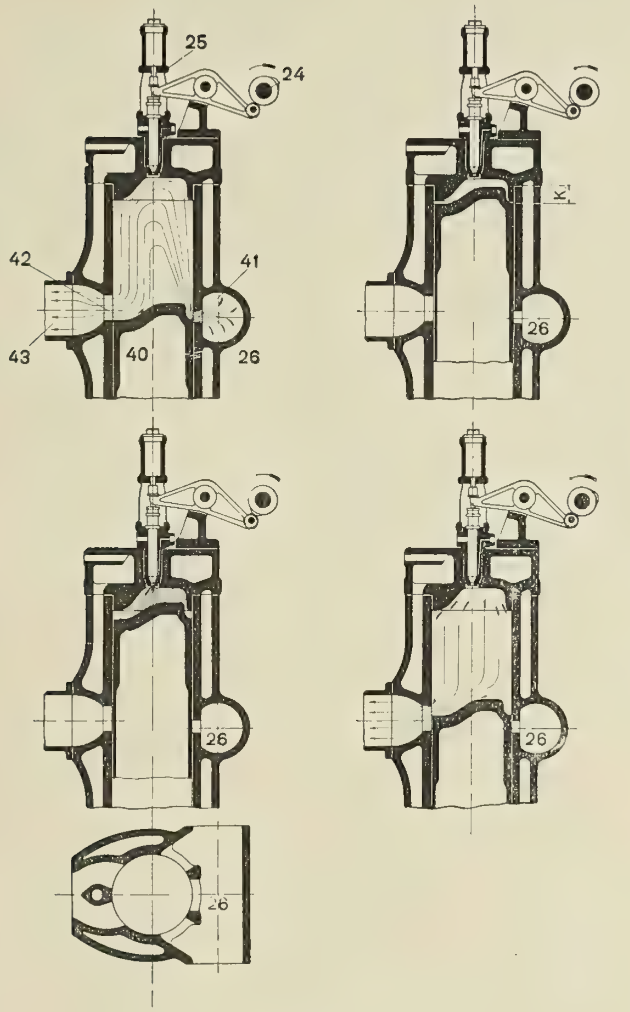


FIG. 4.

Over a year and a half ago the first marine polar motor was installed in a new steel schooner of 300 tons dead weight cargo capacity by the Diesel Motor Company, Ltd., Stockholm, Sweden, the builders of this type of motor. This first motor was of 60-brake horsepower and was originally fitted as an auxiliary, but it has been found economical to keep the engine running constantly when under way in all kinds of weather.

Two 110-brake horsepower motors were also installed in two cargo vessels, the *Rapp* and *Snap,* designed for trading between ports on Lake Vännern, Gottenburg, and the North German Baltic ports. These boats are 105 feet long over all, with a molded breadth of 22 feet 5 inches, a depth of 10 feet 1 inch and a cargo capacity of 300 tons dead weight.

In Fig. 5 is shown the tug *Jakut,* belonging to the oil firm of Nobel Brothers, St. Petersburg, in which are installed two marine polar motors of 160-brake horsepower each. The dotted lines indicate where the old steam machinery was installed, and the saving in space with the oil engines is apparent. It is of interest also to note that the polar ship *Fram,* well known from the polar expedition of F. Nansen, has recently had its steam engine replaced by a marine polar motor of 180-brake horsepower.

Proposed installations for cargo vessels have been worked out to show the advantages of the oil engine. As an example, may be cited a 210-foot cargo vessel with a capacity of 1,400 tons dead weight. The beam of the vessel is 32 feet, the molded depth 15 feet 7 inches, and the load draft 14 feet 3 inches. Propulsion is by means of a marine polar motor of 650 indicated horsepower, giving the ship a speed of 9½ knots. The weight of the propelling machinery is, approximately, 44 percent of the weight of a corresponding steam installation. Forty tons are allotted as the weight of fuel to be carried, and this is sufficient for an uninterrupted run of fourteen days with the oil engines. The same weight of coal would last for a run of three days only. The difference in the weight of fuel means an increase in cargo capacity of not less than 13 percent in the oil-driven ship. With the steam engine it would also be necessary to increase the length of the engine room about 44 percent.

The question of driving the auxiliaries is, of course, an important one, and must be met in an oil-driven ship. In the cargo vessel just described, provision is made for electric lighting by a generator driven by a small Diesel motor. The winches are operated by compressed air from the main engines. The steering gear can also be driven by compressed air. Electricity can be used for heating if its expense is not prohibitive. Heating can, however, be very satisfactorily accomplished by hot water from a small boiler, either fired with oil fuel or incorporated in the exhaust silencer of the motor.

Coming to the cost of operation, in addition to the economy in fuel the use of the oil motor permits a reduction in the engine-room staff, which is a direct economy. In the cargo ship just described, the engine-room staff is reduced by at least one engineer and one oiler, as compared with a steam plant.

In Germany, as is well known, the question of auxiliary sailing ships has been investigated widely, and German auxiliary sailing ships have already successfully competed with tramp steamers. This would seem to indicate that the use of auxiliary sailing ships as cargo carriers can be developed to a much greater extent than is now the case by the use of a motor such as has been described in this article.

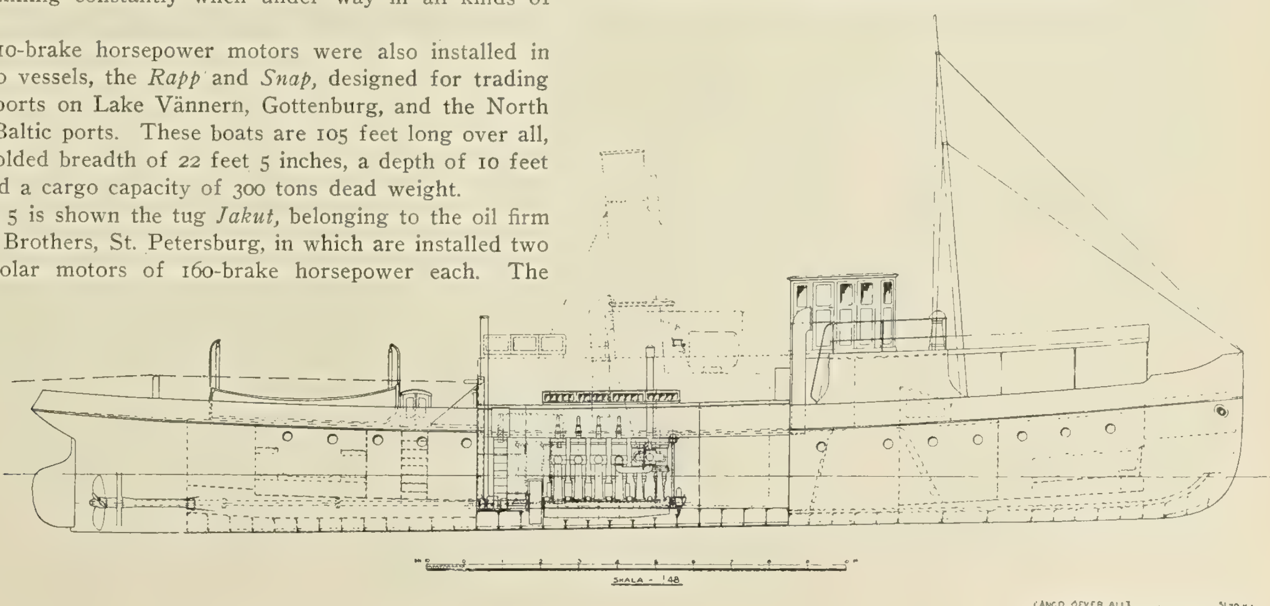


FIG. 5.

LÄNGD ÖFVER ALLT	31,70 M
" MELLAN STÄFVAR	30,50
STÖRSTA BREDD	6,66
" DJUP	1,55

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Electric Drive for the Propulsion of Ships.

All proposals for the application of electricity to the propulsion of ships have arisen from an effort to bridge the gap between the economic speed of high-speed prime movers and the relatively low efficient speed of propellers. Since the advent of the steam turbine, which is essentially a high-speed engine, and which gives the best economy in steam consumption at high speeds, the need of some such device has become very urgent, and numerous attempts have been made to design an efficient speed reduction gear which, within the limits of weight, space and cost available in the design of a ship, can be used successfully. Practical solutions of this problem by means of spur gearing and by hydraulic gear are now before the public, and two separate methods of using electricity for this purpose were described by Mr. W. L. R. Emmet at the annual meeting of the Society of Naval Architects and Marine Engineers.

The thing which makes Mr. Emmet's paper of so much value is the fact that it is based not upon mere theories in which numerous loopholes for doubt may be found, but upon actual facts and designs which have been worked out in every significant detail, and which might, if opportunity offered, be contracted for immediately. The author even goes so far as to state that the designs would be fully guaranteed. With such carefully worked-out and thoroughly practical designs as a basis for consideration, these proposals merit the most careful investigation.

Both methods suggested by Mr. Emmet provide for twin screws and, for the sake of comparison, the propeller speed and other details are taken the same as for a direct drive by Curtis turbines, which was the design actually adopted in the ships for which these systems of electric drive were proposed. Since, however, the main object of the electrical apparatus is to introduce a speed-reducing bond between the turbine and the propeller, better results than those set forth in the paper could be obtained by selecting the best propeller speed for the ship and then designing the electric motors to obtain this speed.

In the first arrangement described, which is designated as a combination drive, there is a low-pressure turbine and an electric motor on each propeller shaft, at high speeds the turbine generating about three-fifths of the total power. The motors are operated from generators driven by high-pressure turbines, from which steam is exhausted into the main low-pressure turbines. Under cruising conditions the high-pressure turbines and electric drive alone are used, the low-pressure turbines running idle. Since reversal is obtained by reverse wheels in the low-pressure turbines, the point was raised in the discussion of the paper of whether with the low-pressure turbine running idle most of the time, and consequently cold, it would be possible to reverse instantly without the possibility of serious damage to the turbine. Experience with large stationary turbines of similar design, however, has shown that live steam can be turned into the reverse stages without previous warming up with no ill effects whatever.

This combination plan of turbines and generators was one actually proposed for the new battleships *Arkansas* and *Wyoming*, the main reasons why it was rejected, beyond the natural hesitancy of attempting on so large a scale an absolutely untried and unknown project, we understand to have been the excessive weight of the installation and its high cost, the bids for this arrangement being about $645,000 (£132,500) above the lowest bid for Parsons turbines. As to the weight, Mr. Emmet's figures show that, disregarding piping, bearings, shafting, valves or

auxiliaries, the combination drive is about 7 percent heavier than that for Parsons turbines alone.

Mr. Emmet brings forward, however, a second method of electrical propulsion, in which each propeller shaft is provided with two motors, one adapted for use at low speeds and the other adapted for high speeds, the generating units in this case being designed to give a very uniform efficiency through wide ranges of load and speed. The reversal in this case is obtained through the motors themselves. This form of drive, as compared with the direct Parsons drive, is shown to be 27 percent lighter in weight, exclusive of piping, bearings, shafting, valves or auxiliaries. Thus it is quite apparent that the disadvantage of excessive weight which exists in the first case can be overcome. The weight of piping for an installation of Parsons turbines with the ordinary arrangement of four shafts is very considerable, since the piping is exceedingly complicated and extensive. Other items, such as the weight of bearings, thrust blocks, valves, etc., would be considerably less in the case of the electric drive than in the case of the direct Parsons drive. Also, it is probable that the boiler weights could be reduced somewhat, since the steam consumption of the turbines would be less when running at their most economical speed.

An interesting possibility was mentioned during the discussion of this paper, and that is the possibility of controlling the ship direct from the bridge if the electric drive were used. There are a number of instances on record where disasters have occurred through a misunderstanding of signals between the bridge and the engine room. Therefore, the advantage of some system of direct control would be inestimable. Since, however, the control of the ship when driven by electricity involves not merely the control of the electrical apparatus, but also the control of the steam turbines which drive the generators, it is hardly to be expected that satisfactory means could be developed for this any more than satisfactory means have been developed for the control of a direct turbine drive. It should be remembered that in the electric drive the variation of speed is obtained by steam and not by electricity, the electrical apparatus forming merely a fixed speed-reducing bond between the turbines and propellers.

Another possibility which undoubtedly would be opened up by the adoption of electric drive is the application of internal-combustion engines as prime movers on board ship. Electric drive, in fact, offers the best, if not the only, solution of this problem at present.

Whether we are justified in assuming that it would be possible to build a large marine power plant of this type without previous experimental installations of smaller power and expect it to succeed, will depend largely upon the faith which individuals have in the ability of the engineering profession to undertake such enormous advances at a single bound. Such steps have frequently been taken, however, particularly in the early days of the steam turbine, as it will be recalled that at the time the turbines were designed for the *Lusitania,* an installation which aggregated 68,000 horsepower, the largest marine steam turbine then built was only 4,000 horsepower. Since we are assured by Mr. Emmet of the practicability of the electrical apparatus, and since his confidence is based upon the fact that motors and generators of exactly the same design which would be used in this case are now being used with good efficiency and unquestioned reliability for such services as mine hoisting, rolling-mill work, etc., where the requirements are far more exacting than they would be for ship propulsion, there does not seem to be much cause for doubting the practicability of the electric drive.

Problems Relating to the Resistance of Ships.

The subject of the resistance of ships furnishes one of the most prolific fields of investigation that is open to naval architects. However settled the design of any type of ship becomes in practice, there is nearly always the possibility of making some change in the form of hull which will diminish the resistance and, consequently, permit either an increase of speed for the same power or a reduction in the power required to attain the designed speed, with a corresponding increase in the dead weight carrying capacity of the vessel. A case in point is the design of the *Monitoria,* which is described on page 477. This vessel is built with two longitudinal corrugations in the shell plating between the load waterline and the bilge, the effect of which is claimed to be an improvement of 5 percent in the speed of the ship over that of a similar ship of the ordinary type at 10 knots.

While such radical improvements as the foregoing are rare, yet the continual investigation of special problems in resistance by means of model tank experiments is steadily increasing the fund of general information which can be brought to bear upon new designs and the improvement of old ones. Particularly valuable in this respect are the researches of Naval Constructor Taylor at the model towing basin in Washington and of Professor Sadler, at the University of of Michigan, and it is gratifying to find among the papers presented at the recent annual meeting of the Society of Naval Architects and Marine Engineers two valuable papers from these authorities bearing upon the general subject of resistance. There may be no way to diminish to any great extent skin or frictional resistance, which in full ships at moderate speeds comprises about 70 percent of the total resistance; but very probably, as in the case of the *Monitoria,* there are forms for ships' hulls yet unknown which will admit of a reduction of that part of the residuary resistance which is due to wave making.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Oct. 1.	Nov. 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons..........	99.0	99.9
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	96.8	97.4
North Dakota	20,000	21	Fore River Shipbuilding Co..	95.2	96.6
Florida	20,000	20¾	Navy Yard, New York.......	33.7	38.3
Utah	20,000	20¾	New York Shipbuilding Co..	44.4	50.0
Arkansas ...	26,000	20½	New York Shipbuilding Co...	0.0	1.0
TORPEDO-BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons..........	98.4	99.4
Lamson	700	28	Wm. Cramp & Sons.........	91.4	92.8
Preston	700	28	New York Shipbuilding Co...	94.8	95.9
Reid	700	28	Bath Iron Works............	94.3	100.0
Paulding ...	742	29½	Bath Iron Works............	36.3	46.1
Drayton	742	29½	Bath Iron Works............	30.5	37.0
Roe	742	29½	Newp't News Shipbuilding Co.	64.6	66.4
Terry	742	29½	Newp't News Shipbuilding Co.	63.9	65.8
Perkins	742	29½	Fore River Shipbuilding Co...	56.0	59.3
Sterrett	742	29½	Fore River Shipbuilding Co...	53.4	58.1
McCall	742	29½	New York Shipbuilding Co...	29.6	34.2
Burrows	742	29½	New York Shipbuilding Co...	29.2	34.2
Warrington..	742	29½	Wm. Cramp & Sons.........	47.3	53.0
Mayrant	742	29½	Wm. Cramp & Sons.........	51.5	54.6
No. 32......	...	....	Newp't News Shipbuilding Co.	1.1	3.2
No. 33......	...	....	Bath Iron Works............	4.0	7.9
No. 34......	...	....	Fore River Shipbuilding Co...	3.2	5.2
No. 35......	...	....	Fore River Shipbuilding Co...	5.3	8.2
No. 36......	...	....	Wm. Cramp & Sons.........	1.7	3.4
SUBMARINE TORPEDO BOATS.					
Stingray	...	..	Fore River Shipbuilding Co...	99.1	100.0
Tarpon	...	..	Fore River Shipbuilding Co...	99.1	100.0
Bonita	...	..	Fore River Shipbuilding Co...	99.0	100.0
Snapper	...	..	Fore River Shipbuilding Co...	99.0	99.3
Narwhal ...	...	..	Fore River Shipbuilding Co...	98.9	100.0
Grayling	...	..	Fore River Shipbuilding Co...	98.5	100.0
Salmon	...	..	Fore River Shipbuilding Co...	86.7	87.0
Seal	...	..	Newp't News Shipbuilding Co.	26.2	28.2
Carp	...	..	Union Iron Works..........	6.0	16.0
Barracuda ..	...	..	Union Iron Works..........	6.1	16.1
Pickerel	...	..	The Moran Co..............	10.7	13.0
Skate	...	....	The Moran Co..............	10.6	13.1
Skipjack	...	..	Fore River Shipbuilding Co..	7.6	8.4
Sturgeon ...	...	..	Fore River Shipbuilding Co..	7.6	8.4
Tuna	...	..	Newp't News Shipbuilding Co.	3.8	7.7

ENGINEERING SPECIALTIES.

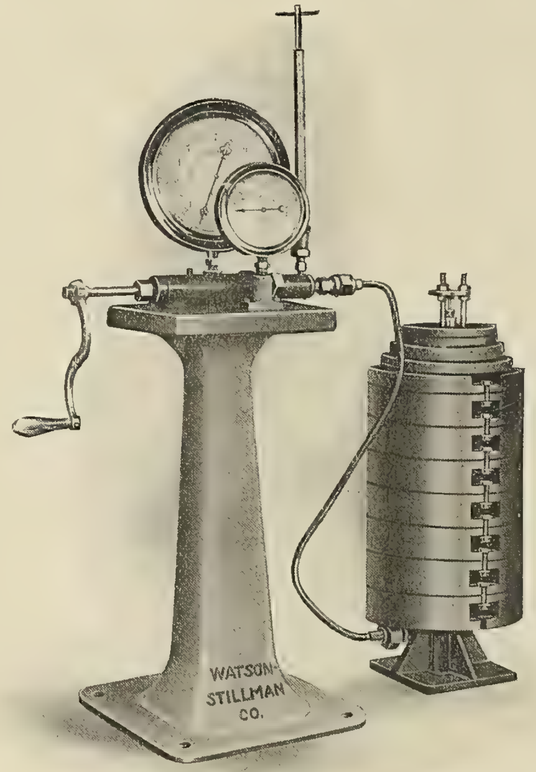
Improved Calibrating Apparatus for Hydraulic and Other High-Pressure Gages.

The bursting of machine parts and fittings from excessive fluid pressure is usually accompanied by considerable danger, expense and delays for repairs. For this reason pressure gages should be calibrated at regular intervals. Under the higher hydraulic pressures it is frequently the case that the same gage will show different percentages of error at different pressure readings, and these can be compensated for in ascertaining the true pressure only by comparing with a "master" gage of known accuracy or by loading with a known pressure.

The outfit which we illustrate performs these two functions of testing by comparison with a master gage and of testing the accuracy of the master.

For the first only the part on top of the stand is required. This consists primarily of a cross made of hydraulic bronze. The gage being tested, which may register any pressures up to 16,000 pounds per square inch, and the master are attached to the front and back ends of the cross respectively. At the left is a crank-operated screw displacement piston, by means of which the desired pressure may be produced within the pressure chamber. A suitable stuffing-box prevents leakage past the piston. To the right end is connected a stop valve and filling cylinder. This permits (1) some of the liquid to be withdrawn from the pressure chamber before removing the gage being tested and (2) filling after a gage is put on. There is thus no danger of spilling the oil.

For testing the master gage, the special weight-loaded, hardened and ground steel piston and cylinder are attached at the right by means of flexible copper tubing, as shown. These parts are cut out by a stop valve when not testing the master. The cylinder is long enough to have the center of gravity of



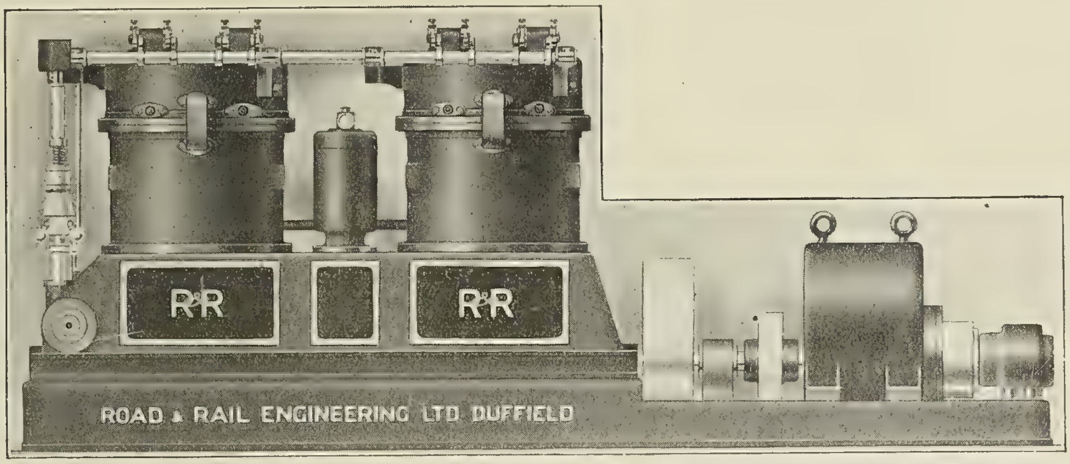
the weight below the center of support. When the weights are revolved the friction due to lifting the weights is practically eliminated.

The aparatus is made by the Watson-Stillman Company, of New York.

Crude Oil Engine for Marine Purposes.

Road & Rail Engineering, Ltd., of Duffield, near Derby, have just placed on the market an internal combustion engine, known as the Duffield crude oil engine, which is designed particularly for use as auxiliary power for small and medium-sized coasting vessels, where the main requirements are small initial outlay, low cost of fuel, ease and simplicity of operation, elimination of dangerous volatile fuels and accessibility for adjustment.

Small capital outlay is necessary, since such engines are used, perhaps, only 2 or 3 hours a day. This has been secured by arranging for a normal speed of 600 revolutions per minute, both for the 25 and 50-horsepower sizes, keeping the maximum pressure within normal limits, and making all parts as plain and simple as possible. The fuel used is crude, unrefined paraffin (kerosene) oil, such as is used for the enrichment of gas in gas works, and which can be bought at almost any English port for half the price of ordinary refined paraffin (kerosene). This fuel can be used with success in this engine, since by means of a novel form of vaporizer the troublesome "hard base," which ordinarily forms tarry deposits in the cylinder and clogs the valves, is entirely removed before the explosive mixture enters the cylinders. The oil is injected under pressure into a form of atomizer and is thrown in the form of a finely divided spray into a cylindrical chamber, which is heated externally by the exhaust gases. Thus that portion of the oil which is suitable for use in the cylinders is vaporized and drawn together with the necessary air into the cylinders. The "hard base," which will not vaporize at ordinary temperature, is thrown against a collector and runs down a drain. At starting, the same atomizer as is used for running is used to blow the flame



through the vaporizer for the preliminary heating. Air is admitted during this process by openings near the atomizer, and, by opening a valve at the end of the vaporizer, the flame passes straight through into the exhaust. No petrol (gasoline) or other spirit is required at starting, neither are external lamps necessary.

The system of governing in this engine is important. The valves controlling both oil, air and the resulting vaporized mixture are acted upon simultaneously, and the relative motions are so designed that, it is claimed, the mixture in the cylinders is always such as to give the maximum efficiency at the particular load on the engine. Over 50 percent speed regulation can be obtained almost instantly. Ignition is either by high-tension trembler coil or low-tension magneto.

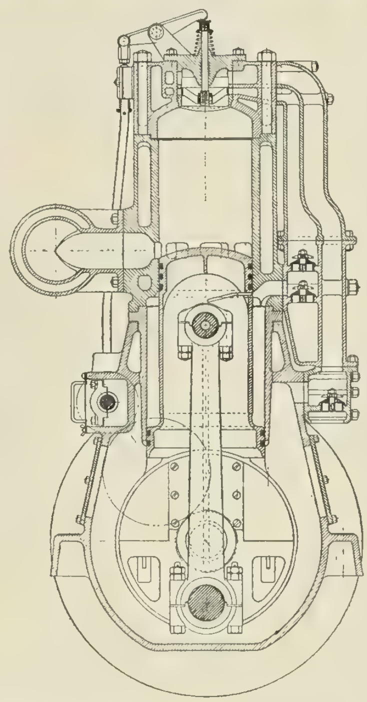
The Straub Marine Two-Cycle Scavenging Engine.

These engines, built by the Page Engineering Company, Baltimore, Md., are of the scavenging type, and resemble in this respect the well-known Korting stationary engines. While the engine is two-cycle in principle, in that an explosion takes place every revolution in each cylinder, the Straub engine otherwise bears scarcely any resemblance whatever to the two-cycle engines as known in the marine trade. In general appearance it is very similar to the four-cycle, having cams and valves, and while it is claimed to be of equal efficiency and reliability, possesses the tremendous advantage of greater power on less weight and space. To this must be added greater simplicity and less first and last cost.

The explosive charge after expansion is completely blown out by a charge of clear air, with perfect scavenging effect, before the fresh charge of explosive mixture is admitted to the cylinder. The admission of the latter is so timed that none of the gas is lost through the exhaust ports. With a clean, cool charge a high compression can be carried with a mean effective pressure equal to the best four-cycle practice.

The Straub scavenging engine was primarily designed to meet the exacting requirements for a successful producer-gas engine, and it is claimed by the manufacturers to be the only engine built in America to-day which successfully fulfills these specifications for marine service. The very elements of design that make for the successful gas engine produce a gasoline engine of equal merit. Both producer gas and gasoline can be used with a change only in compression.

The cylinders and pistons are trunketed, the working, or explosive, cylinder being of the ordinary construction, with the exhaust ports extending around the entire circumference of the cylinder. The exhaust gases pass with the utmost freedom from the cylinder to a large water-jacketed exhaust manifold or receiver, bringing the pressure almost instantaneously to atmospheric, if not, indeed, creating something of a vacuum in the cylinder itself, due to the velocity of the exhaust. The cylinder and piston are enlarged below the exhaust ports, thus forming an annular ring or space, which serves as the gas compressor. Clear air only is compressed in the base, and of a volume about 50 percent in excess of both the working piston displacement and clearance in the combustion chamber, the full diameter of the enlarged piston being effective for this purpose. Both air and gas are admitted to the cylinder through a mechanically-operated inlet valve in the cylinder head. This valve is so controlled that part of the air is admitted first, and completely blows out the burnt gases, not only performing the scavenging function but



also cooling off the igniter, valve, interior of the cylinder and head of the piston. A further opening of the valve admits the gas, which mixes intimately with the air from the base. It is claimed that no back firing is possible, and the charge being fresh and cool a compression of 85 pounds on gasoline and 150 pounds on producer gas can be obtained without pre-ignition.

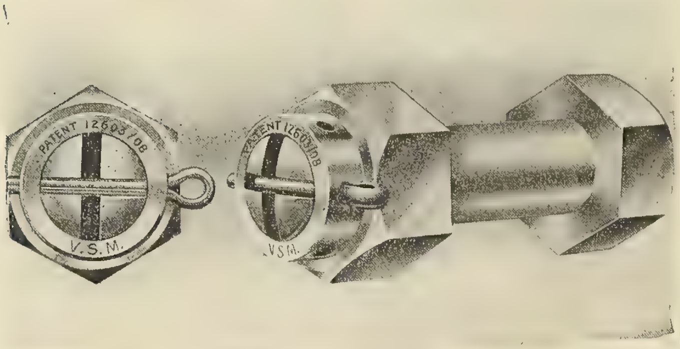
These engines adapt themselves very favorably to air-starting and reversing, and three-cylinder engines of this type are equivalent in this respect to the six-cylinder of the four-cycle type, same bore and stroke. In fact, the mechanism required for reversing is so simple that the operation can be compared very closely to that of a steam engine with one lever for the throttle and one lever for the reverse. The ignition is

either make-and-break or jump-spark, with magneto-geared or Bosch magnetic make-and-break.

These engines are built in three-cylinder sizes: 7 inches by 9 inches, 2, 3 and 4 cylinders rating on gasoline up to 60 horsepower at 350 revolutions per minute; 9 inches by 12 inches, 2, 3, 4, 6 cylinders rating up to 200 horsepower on gasoline at 300 revolutions per minute; 12 inches by 16 inches, 3 and 4 cylinders rating up to 200 horsepower on producer gas at 225 revolutions per minute.

The V. S. M. "Turret" Lock Nut.

The collar of the "Turret" nut, manufactured by Vickers Sons & Maxim, Ltd., 32 Victoria street, London, S. W., is provided with six or more adjusting split-pin holes, and the bolt with one or two slots, according to its diameter. The holes and the slots combined, as will be seen from the illustration, allow of a fine adjustment; in the 1-inch size, for instance, the lineal movement for each step between nut and bolt would be

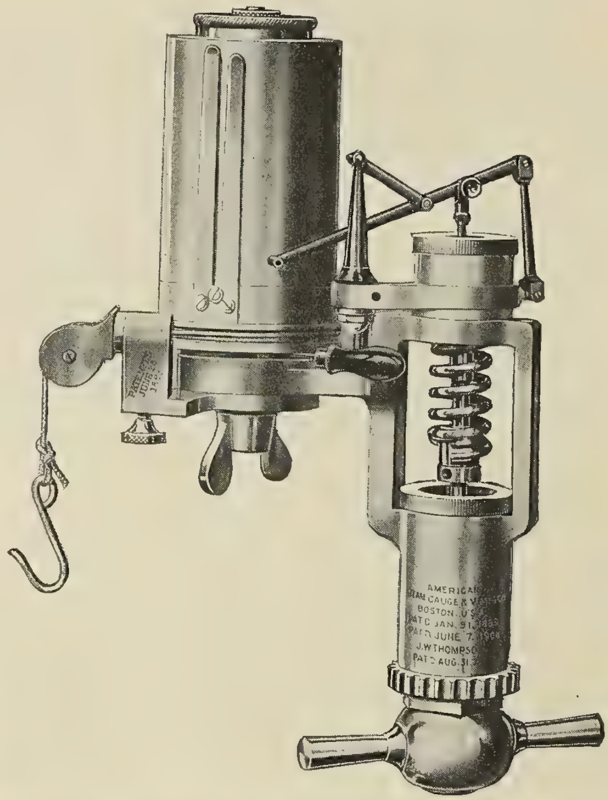


.005 inch. The holes for split-pins and the slot in top end of bolt are always in view, making it easy to locate the alinement of both, and so preventing the workman from overstressing them; further, the slot in bolt can be used with a screwdriver to prevent any turning when nut is being screwed on. This removes any necessity for "feathers" or hexagon headed bolts, and adds to the economy gained by using the device.

The American Thompson New Exposed Spring Improved Indicator.

With all the activity which has been stimulated in the indicator field during recent years, it is interesting to note the latest development of the original Thompson indicator, made by the American Steam Gauge & Valve Manufacturing Company, Boston, Mass. This new indicator, shown in the accompanying illustration, is styled by its makers the "American Thompson New Exposed Spring Improved Indicator." Although this new indicator has been in the process of development for some time, it has been but recently placed on the market, yet the success with which it has met, and the commendation it is everywhere receiving, make it worthy of special mention, as it is claimed to be one of the most practical and successful improvements in the development of indicators since the invention of the detent motion.

One of the basic causes for the superior accuracy of the American Thompson indicator, is the short piston rod which the spring surrounds; in other words, the shorter the piston rod, the less the liability of binding, and therefore the greater uniformity and accuracy. This new type of exposed spring is accomplished without increasing the length or weight of the piston rod to any appreciable extent, thus avoiding any increase of inertia in the moving parts; an error of design



liable to be found in outside spring construction. This design is claimed to accomplish all the accuracy originally gained with the short piston rod, with the advantage which all exposed or outside springs possess of being impervious to the effects of heat or cold, and readily changed.

Annual Meeting of the American Society of Mechanical Engineers.

The thirteenth annual meeting of the society will be held in the Engineering Societies' building, 29 West Thirty-ninth street, New York, Dec. 7 to 10.

TECHNICAL PUBLICATIONS.

Machine Shop Drawings. By Fred H. Colvin. Size, 4½ by 6¾ inches. Pages, 139. Figures, 91. New York, 1909: McGraw-Hill Book Company. Price, $1.00 net.

This little book, which is of convenient pocket size, is intended to help those who do not thoroughly understand the reading of drawings rather than as an attempt to teach drawing itself. The first thing an apprentice must learn in any kind of machine work is how to read a drawing. Familiarity with reading of drawings leads easily to the making of the drawings themselves. Many actual examples are given in the book from the drawing-room practice of the leading shops in America and the meaning of each is carefully explained. Some attention is given to laying out work, such as gearing of different kinds, and some hints are also given in regard to sketching.

Slide Valve Motion for Marine Engineers. By Peter Youngson. Size, 7¼ by 9¾ inches. Pages, 132. Figures, 74. Glasgow, 1909: James Munro & Company, Ltd. Price, 5s. net.

Various attempts are frequently made to fill in the gaps between purely theoretical and purely practical training in various lines of mechanical work by means of books treating of theoretical subjects in a practical way. This book comes under this class, and is intended primarily to give an apprentice as good a practical knowledge as possible of the design, construction and handling of various types of valve gear be-

fore he has an opportunity for actual sea service. Not only will those students who lack practical experience find the book useful, but also seagoing engineers who lack theoretical training will find the book equally interesting and instructive. It is clearly and concisely written and amply illustrated with detailed diagrams. The final chapter includes 100 questions on slide-valve motion which have been selected from Board of Trade examinations. A thorough mastery of this book should give the applicant for a Board of Trade certificate reasonable confidence to approach the examinations relating to slide valves.

Engine Lathe Work. By Fred H. Colvin. Size, 4½ by 6¾ inches. Pages, 180. Figures, 127. New York, 1909: Hill Publishing Company. Price, $1.00 net.

The fundamental principles of the proper running of all machine tools, while well known by the older mechanics, must be learned by apprentices and younger machinists. This book is offered as an aid to such young men, and, therefore, it is not intended to present anything startlingly new in the way of machine-shop practice. The suggestions and methods outlined represent, however, good shop practice; and while they have been written especially for those with a limited experience, it is quite probable that many ideas and suggestions may be new to some of the older men who have not had a chance to see what other shops are doing. Naturally, the first chapter of the book is devoted to a detailed description of the engine lathe. Following this the various operations are described.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

920,283. FLOATING DRYDOCK. WILLIAM THOMAS DONNELLY, OF BROOKLYN, N. Y.

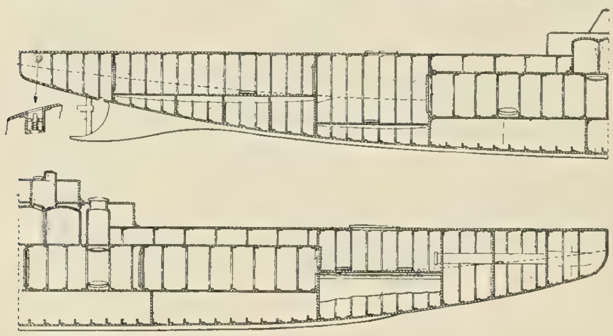
Claim. 2.—In a floating drydock, pontoons comprising transverse beams at top with spaces between them, transverse beams at the bottom with spaces between them, longitudinal beams at the top and bottom, a truss member, diagonal braces, and tension members having plates that are mounted on and bridge the longitudinal beams in the spaces between the transverse beams. Three claims.

925,506. APPARATUS FOR CONDENSING STEAM. DANIEL ARTHUR QUIGGIN, OF LIVERPOOL, ENGLAND.

Claim 1.—In apparatus for condensing steam or for heating or evaporating water by steam, a casing, tube plates, heat transmitting surfaces within said casing and connected to the tube plates, comprising straight or substantially straight tubes having each a trough or troughs extending longitudinally thereof on its upper side, the tubes being arranged with a slope so as to collect and convey to one end of the tubes and casing the drainage resulting from the condensation of the steam on the outer surface of the tubes. Five claims.

926,007. SUBMARINE OR SUBMERGIBLE BOAT. SIMON LAKE, OF BRIDGEPORT, CONN., AND EDWARD LASIUS PEACOCK, OF WEST MOUNT, MONTREAL, QUEBEC, CAN., ASSIGNORS TO THE LAKE TORPEDO BOAT COMPANY, A CORPORATION OF NEW JERSEY.

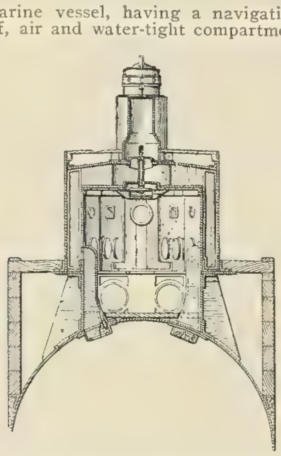
Claim 2.—A submarine or submergible boat, constructed with an intermediate double-compartment section, a substantially semi-circular hull portion arranged below the section, bow and stern sections extending



from the ends of the said double-compartment section and from the said hull portion, the axes of which are upwardly inclined toward the extreme ends of the boat. Fifteen claims.

926,065. SUBMARINE VESSEL. SIMON LAKE, OF BRIDGEPORT, CONN.

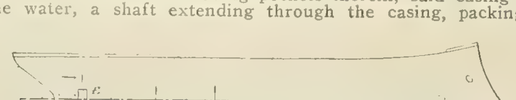
Claim 5.—A submarine vessel, having a navigating turret extending from the hull thereof, air and water-tight compartments arranged in the



turret, one of which forms an air duct which communicates with the hull of the vessel, a valve-controlled opening leading into the duct, and a valve controlling the inner end of the duct. Twenty-eight claims.

928,957. STEERING MECHANISM. LOUIS GABETTI, OF HOBOKEN, N. J.

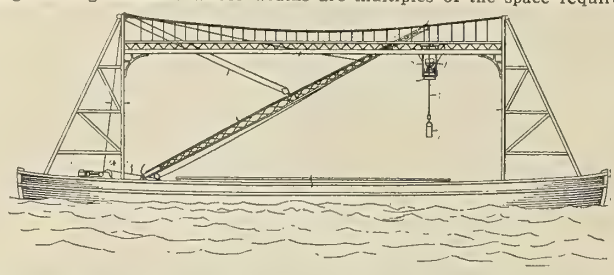
Claim 1.—In a steering mechanism for vessels, a casing formed in the side of the vessel and having pockets therein, said casing opening into the water, a shaft extending through the casing, packing plates



arranged in said pockets, and connected to said shaft, a frame in which the shaft is journaled, a steering propeller arranged in the casing and carried on the shaft and means for shifting said frame. Two claims.

929,139. BARGE. HENRY WILLIAM KIRCHNER, OF ST. LOUIS, MO., ASSIGNOR TO RIVER & RAIL TRANSPORTATION COMPANY, OF GUTHRIE, OKLA., A CORPORATION OF OKLAHOMA.

Claim 9.—The combination with a barge of a plurality of interchangeable boxes, each having fastening devices at its ends, said barge having divisions whose widths are multiples of the space required



by a single box, and the partitions between the divisions of a barge being provided with means for co-operating with the locking devices on the boxes, and with horizontal tracks, and skids on said tracks for supporting said boxes. Ten claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 4 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

9,679. PROPELLERS. P. ST. G. KIRKE, SCOTLAND.

Claim.—Water enters and is by vanes rotated so that the centrifugal action maintains a constant pressure on its outer walls, whilst its rate of axial flow is not retarded. The rotary direction is changed by other vanes to an axial, rearward direction for propelling the vessel. A smaller similar propeller may be used in running astern and may be combined with the main propeller.

23,981. DREDGING. J. M. CRYER, POULTON-LE-FYLDE, AND C. A. HOLT, BOLTON, LANCASHIRE.

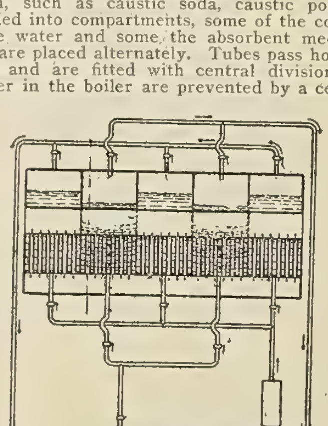
In dredging apparatus for cleaning mill and other reservoirs, one or more portable pontoons are employed, which are adapted to be readily taken to pieces for storage or removal from one reservoir to another. The deck has a baseplate with a footstep for the central post of a crane carrying a dredging bucket. The sludge pump, also located on the deck, may be provided with flexible suction piping having a rose or nozzle at its end.

27,266. SUBMARINES. A. J. KEMP, F. W. RANDALL, SOUTHSEA, AND F. A. PRIMROSE, FOLKESTONE.

Claim.—The fine adjustment of the degree of submersion or immersion of submarines is here effected by simultaneously controlling the admission and discharge of water to or from the auxiliary ballast tanks, a pair of which is provided equidistant fore and aft of the buoyancy center and preferably on opposite sides of the vessel. These tanks have displacers or pistons actuated by screws, which engage a cross-head fast on the piston rod. The screws are turned by wormwheels engaging worms on a shaft, which also similarly operates the other displacer or piston, a portion of the shaft being provided with universal joints or other devices to allow transmission of power from one side of the ship to the other.

26,794. SUBMARINE VESSELS. R. D'EQUEVILLEY-MONTJUSTIN, KIEL, GERMANY.

The steam required to drive the prime mover for the propulsion of submarine vessels is generated in a boiler, fired in the ordinary way, when the vessel is awash; but when the vessel is submerged, the steam is generated in the well-known way in fireless boilers, by means of an absorbent medium, such as caustic soda, caustic potash, or the like. The boiler is divided into compartments, some of the compartments being adapted to receive water and some the absorbent medium. Preferably the compartments are placed alternately. Tubes pass horizontally through the compartments and are fitted with central divisions. Lateral oscillations of the water in the boiler are prevented by a central longitudinal



division. Under the boiler is situated the heating channel for oil firing, from which heating tubes lead through the compartments to the smoke passage. From the compartments steam is led to the engine from which it is exhausted by pipes leading to the compartments and the condensed respectively. The condensed steam is pumped into the boiler in ordinary running; but when submerged, the steam passes through the soda solution in the compartments, and the heat generated is utilized in evaporating the water in the other compartments. When the vessel is again awash, the heating chamber is once more used, and the water taken up by the soda solution will be returned to the condenser. Cocks and valves are fitted as found necessary.

TRADE PUBLICATIONS.

AMERICA

The Buffalo fan system of heating and ventilating is explained in detail and fully illustrated in catalogue 197 published by the Buffalo Forge Company, Buffalo, N. Y.

The Wheeler-Edwards air pump is the subject of a 32-page treatise published by the Wheeler Condenser & Engineering Company, Carteret, N. J. The peculiar action of the Wheeler-Edwards pump in handling both air and water is explained, and it is shown how the absence of foot and bucket valves, and an exceedingly small clearance, results in the attainment of a high vacuum, otherwise to be had only by means of separate dry vacuum pumps, hot-well pumps and air coolers. Various types of Wheeler-Edwards pumps are shown, also a number of large steam turbine installations in which these pumps are used. The latter half of the book is made up of discussions of the principles of air pumps, tables of mixed vapors, a complete and original table of saturated water vapor from 60 to 180 degrees F., etc. The final section gives practical instructions for the handling of pumps of this character. This booklet should be valuable to anyone interested in vacuum machinery.

Stereo binoculars are described in an illustrated catalogue published by the Bausch & Lomb Optical Company, Rochester, N. Y. "In presenting this booklet, we again bring to your attention the wonderful improvements which recent years have worked in field glasses by the addition of the Bausch & Lomb-Zeiss binoculars and by the introduction of the novel optical principles upon which they are based. The field glass was then converted from a heavy, unwieldly instrument into a binocular of such concentrated power that it becomes at once an appreciated companion in peace and a necessity in war. All of the objectionable features present in the older type of glasses have been eliminated in our present instruments. To secure compact construction and great power, Porro prisms and astronomical eyepieces are called into service, resulting in an eight-power glass measuring but 4 inches in length. The Porro prisms cause the rays to be bent upon themselves in such a way as to greatly shorten the glass and at the same time the inverted image given by the objective is reinverted and seen in its natural position. To secure lightness in weight, aluminum, carefully ribbed for strength, is used for the body, which is handsomely and durably finished."

Turret lathes are described and illustrated in a vest-pocket calendar just issued by Pratt & Whitney Company, 111 Broadway, New York City, in which the statement is made that the variety of sizes of this style of turret lathe enables the manufacturer to install a machine particularly applicable to the work to be done.

Users of slow-speed, heavy-duty gasoline engines, suitable for fishing boats, tugs, working boats, heavy cruisers, etc., should write to the Buffalo Gasolene Motor Company, 1209 to 1221 Niagara street, Buffalo, N. Y., mentioning this magazine, and ask for a free copy of this company's catalogue, just published. Not only are gasoline engines of the type mentioned listed in this catalogue, but also the company's regular type 2 to 100 horsepower, with two to six cylinders, and the high-speed type 50 and 75 horsepower, four and six cylinders. The catalogue is a handsomely illustrated 48-page book. The Buffalo line for 1909 includes eleven sizes of the regular type of medium weight, medium speed engines; eight sizes of the company's slow-speed, heavy-duty type, and the new Buffalo type of light-weight high-speed engines, built in four and six cylinders, sizes 6¼ inches by 6¾ inches.

A valuable machine tool catologue has just been issued by Manning, Maxwell & Moore, 85 Liberty street, New York City. This is a 9 by 13½ cloth-bound volume of 1,174 pages, containing 2,570 illustrations. The publishers state that it is the only catalogue in existence gi ing a thorough presentation of modern machine tools destined for service with high-speed steel and the latest devices in motor drives. The tools illustrated and described are carefully grouped, in order to enable any one examining the book to conveniently investigate the different lines of machine tools. For example, the first 125 pages are exclusively devoted to a general line of tools for service in railroad machine shops. A large section is devoted to electric traveling cranes, dock cranes, wrecking cranes, and similar devices; other sections to lathes of every description, steam hammers, punches and shears. Other machines of special interest to boiler makers, railway shops and shipbuilders are largely represented. The book is beautifully printed, and the half-tone illustrations are all of excellent quality. The catalogue should prove of great value to all purchasers of machine tools of any description.

The Copes pump governor and boiler feed regulators are described in a catalogue distributed by the American Boiler Economy Company, North American building, Philadelphia, Pa.

Manganese bronze, for propellers, connecting rods, hydraulic machinery, etc., is the subject of a folder published by the Lumen Bearings Company, Buffalo, N. Y. These circulars give a table showing the comparison between the strength of this company's manganese bronze and the usual government specifications. The government specifications call for a strain per square inch of 60,000 pounds; whereas, tests of the Lumen Bearings Company's bronze are stated to have shown in every case much higher tensile strength, in one instance showing as high as 80,690 pounds.

The Bucket Catalogue just published by the Brown Hoisting Machinery Company, Cleveland, Ohio, covers thoroughly the product of the company in this line. "Brownhoist" grab buckets for handling coal, etc., are used the world over, and are said to be generally recognized as the most efficient grab buckets on the market. The well-known two-rope buckets and pockets are used on many different types of machines. The "Brownhoist" single-rope buckets, for use on existing machines having but a single drum engine, are also described and pictured. Automatic dumping tubs, shovels, buckets, etc., are also shown. The printing and illustrations of this catalogue are beautifully done, and a heavy coated paper is used. A free copy will be sent to any of our readers mentioning this magazine.

Chain blocks, electric hoists, trolleys and cranes are described in a handsomely illustrated catalogue published by the Yale & Towne Manufacturing Company, 9 Murray street, New York City. These hoists are used for a great variety of purposes, in engine rooms, boiler shops, locomotive works, car factories, etc. Regarding this company's electric hoists the statement is made, "The efficient handling system does not require a crane to neglect heavy work and hurry across the shop to take care of some small lift. The practical equipment includes electric cranes for heavy loads, electric hoists for constant lifting in serving machines or assembling, and small electric hoists or chain blocks for conveying small pieces in all stages of manufacture. The electric hoist is as important in the average shop as the heavy crane. A large number of lifts in a short time by manual labor is an expensive item. Electric hoists are economical, even when substituted for the cheapest labor. They are in a class midway between chain blocks and heavy-duty traveling cranes, giving from five to ten times the speed of hand hoists and costing only the fractional part of electric traveling cranes. An electrical hoist will operate continuously all day on from 15 to 40 cents' worth of power. Any shop can install overhead handling systems of I-beam track or swinging jib cranes. The cost is moderate and the head room limited. Supplementary small hoists increase 50 percent or more the efficiency of the heavy cranes."

"Our New Product" is the title of Bulletin No. 158 of the engineering series published by the B. F. Sturtevant Company, Hyde Park, Mass. "A glance at the following pages shows that we have made a special study of centrifugal fans, the methods and machines for driving them, and the apparatus with which they are used, such as heaters, economizers, forges, dust collectors, etc. In other words, the B. F. Sturtevant Company are blower and fan specialists. For fifty years we have been building centrifugal fans. During this period constant progress in design and improved methods of construction have made Sturtevant blowers and exhausters the most efficient and satisfactory for every condition—large or small volume, at high or low pressure, and for high or low rotative speed. This is the result of improving the blower itself, and, what is of greater importance, making it best suited commercially to heating, ventilating, drying and mechanical draft apparatus. Sturtevant blower sets are compact units, of very high mechanical efficiency, and easily operated. The motors, engines or turbines were designed especially for direct connection to blowers and exhausters, the speeds and powers coinciding with the most economical blower speeds. These sets, with heaters, economizers, forges, etc., are in constant operation in many of the largest industrial plants, power houses and public buildings. Another result of fifty years' experience in building and using centrifugal fans is the largest plant in the world devoted to the manufacture of blowers, exhausters and allied apparatus. Such facilities provide means for testing all apparatus under proper conditions. The complete lines enable us to carry on extensive research work, to which we owe our pre-eminent position in the centrifugal fan business."

The index data cards published by the Hess-Bright Manufacturing Company, Philadelphia, Pa., have been extended in scope to cover a wider field for engineers, designers and draftsmen. The first sheets of a standard 9 by 12 series have just been issued, and are devoted to pictorial explanations of the principles of correct mounting of ball bearings.

The Almy Water Tube Boiler Company, Providence, R. I., is distributing a folder calling attention to the good points claimed for this company's boiler, among which are perfect circulation of the water, safety, durability and economy. It is said that 5 or 10 percent of coal is saved each day in getting up steam because of the boiler's ability to steam quickly.

Marine engines are described in an illustrated catalogue just published by Termaat & Monahan Company, Oshkosh, Wis. The statement is made that this catalogue is published in the interest of marine motor power, and while it has made special reference to the details and results of Termaat & Monahan engines and accessories, it contains information of great value to all operators of marine gasoline engines.

"The Motor that Motes," made by the Bridgeport Motor Company, Bridgeport, Conn., is the subject of an illustrated catalogue just issued. The catalogue calls special attention to the absence of radical changes in the company's 1909 motors. Aside from general refinement of detail no material changes have been made for several seasons, as the manufacturers state that all weak or objectionable features were obliterated long ago. This company makes a specialty of a heavy, slow-speed motor suitable to large, heavy-working boats.

The "Swartwout" cast iron exhaust head and centrifugal steam and oil separator are described in an illustrated catalogue published by the Ohio Blower Company, Cleveland, Ohio. The catalogue states that the "Swartwout" apparatus is the practical evolution of a theory born of years of experience in the separation of entrained particles from air and steam. This catalogue also explains the development of the helico-centrifugal principle, of which the "Swartwout" apparatus is said to be a practical application.

The Ryan-Canning boat-handling device, made by the Boat Handling Gear Company, 91 Wall street, New York, is described in an illustrated catalogue this company has just issued. This device recently received a demonstration on the Ward liner *Havana,* when the following result is stated to have been obtained: A 27-foot lifeboat, weighing about 2 tons, was unlashed, swung out, lowered 50 feet into the water; tackles unhooked, guys and boat painter secured, boat cleared of the ship, with men in it, in 37 seconds; the entire operation being carried on by four men only.

Air compressors are described and illustrated in publication No. 386 distributed by the National Brake & Electric Company, Milwaukee, Wis. The statement is made that this company, to satisfy the demand for compact, self-contained air compressors, so constructed as to be free, as far as possible at all times, from breakdowns, has perfected and placed upon the market an extensive line of air compressing apparatus, including both stationary and portable motor-driven compressors, belt driven and direct-connected types, and combined air compressor and water pump units.

Ship carpenters' tools and other tools are described in an illustrated catalogue of 48 pages published by the Snell Manufacturing Company, Fiskdale, Mass., a free copy of which will be sent to any reader mentioning this magazine. In this catalogue the company especially calls attention to its new line of solid auger bits, which are warranted equal in every respect to any made in the world, both for quality of the manufacture and for the excellence of their boring qualities. This company carries a very full line of ship auger bits, and they are fully illustrated and described in addition to having a price list attached. Among the other tools described and illustrated in this catalogue are boring machines, screwdrivers, reamers, cold chisels, etc.

Ball and roller bearings are the subject of illustrated catalogue No. 24 just issued by the Standard Roller Bearing Company, Philadelphia. This is a volume of 200 pages, and explains in full the various uses to which roller and ball bearings are put. The statement is made that the use of roller bearings in machine construction has increased greatly during the past few years. This company's roller bearing propeller thrusts are said to be especially adapted for use on launches and marine motors and engines. For a heavier class of vessel the company makes a special bearing, and is prepared to apply its bearings to any size of steam vessel, the result being, according to the manufacturer, that speed is increased and the consumption of coal and oil greatly reduced.

Steam boiler specialties, such as blow-off valves and gage cocks, are described in a catalogue distributed by the A. W. Cadman Manufacturing Company, Pittsburg, Pa.

Eureka packings and Robertson Thompson indicators are among the steam specialties described in circulars distributed by J. L. Robertson & Sons, Inc., 48 Warren street, New York City.

Suction gas power plants are the subject of a catalogue published by R. D. Wood & Company, Philadelphia, Pa. This contains illustrations of which the statement is made that they clearly indicate the basis of the superiority of gas plants.

Coal handling machinery for coaling stations, shipyards, boiler rooms, etc., is the subject of a very complete 64-page catalogue, No. 072, issued by C. W. Hunt Company, West New Brighton, N. Y. Any one interested in this class of machinery should send for a copy of this catalogue, which will be sent free to readers mentioning this magazine.

Compressors of many kinds are the subject of Bulletin 36-A, issued by Ingersoll-Rand Company, 11 Broadway, New York City, manufacturer of pneumatic appliances and tools of every kind. Publications devoted to all this company's products will be sent free to readers of this magazine upon application.

A free copy of the extra edition of Catalogue No. 7, published by the Smooth-On Manufacturing Company, Jersey City, N. J., and 8 White Street, Moorfields, London, E. C., will be sent to any reader who will mention this magazine. The demand for the first edition of this catalogue was so great that the supply was soon entirely exhausted. This catalogue describes the Smooth-On Manufacturing Company's iron cements of various kinds.

The latest number of *The Engineer and Fireman,* published by the Penberthy Injector Company, Detroit, Mich., contains a number of interesting articles, among them being "Home Study for Engineers," "Engine Horsepower," "How to Avoid Breakdowns," etc. Every new subscriber to *The Engineer and Fireman* will receive a handsome watch fob.

The White Star oil filter is described in circulars issued by the Pittsburg Gage & Supply Company, Pittsburg, Pa. This filter, according to the manufacturer, is an inexpensive device of high efficiency for purifying used-oil from machinery bearings, so that it may be fed again to the rubbing surface, and thus be used over and over until actually worn out in the work of lubrication.

"Graphite's" Tenth Birthday.—With the December issue, *Graphite*, published by the Joseph Dixon Crucible Company, Jersey City, N. J., celebrates its tenth anniversay, and to commemorate the event it issued a special number, containing, among other interesting articles, a sketch of graphite and the seventh chapter of W. H. Wakeman's article on "Preventing Corrosion of Steam Machinery."

Milling machines, die sinkers and profilers are described in a handsomely illustrated catalogue published by Pratt & Whitney Company, 111 Broadway, New York City. These are precision tools, and are said by the manufacturer to be especially adapted for high-grade milling that is required to produce accurate work. Complete groups of machines with cutters, fixtures, gages, etc., will be quoted upon when requested.

A Manual for Engineers.—The American Blower Company, Detroit, Mich., write us that they have a limited supply of these books, which have been compiled by Prof. Charles E. Ferris, of the University of Tennessee. They are leather-covered, vest-pocket size. The company will send a free copy as long as the supply lasts to any reader mentioning this magazine.

Valves are described and illustrated in a catalogue just published by the American Steam Gauge & Valve Manufacturing Company, 208 Camden street, Boston, Mass. Among the valves this company makes are the American marine board of trade pop safety valve; the American duplex pop safety valve for marine and stationary boilers; the American triplex pop safety valve for marine and stationary boilers; the American board of trade twin pop safety valve; the American duplex improved pop safety valve with long spring; the American improved marine pop safety valve, navy pattern, and many others. All of these valves are fitted with American adjustable blow-down rings. A great many other specialties described and illustrated in this catalogue are of interest to marine as well as stationary engineers.

TRADE PUBLICATIONS

GREAT BRITAIN

Milton & Company, 66 Victoria street, Westminster, S. W., have issued a catalogue giving particulars and illustrations of Macfarlane & Reid's patented self-oiling blocks and sheaves. It deals with purchase blocks for wire and manilla rope, open-frame cargo or lead blocks for ⅝-inch or ⅞-inch chain, malleable-frame cargo blocks, cargo or lead blocks for wire rope.

John Musgrave & Sons, Ltd., Globe Iron Works, Bolton, have issued a new catalogue dealing with the Zoelly steam turbine. The catalogue is a very interesting publication, and it contains a number of illustrations showing turbines complete. A good description of the Zoelly steam turbine is given, and its advantages are shown. Other sections of the catalogue deal with dimensions and consumption of high-pressure turbines, exhaust-steam turbine, steam consumption of exhaust turbines, and mixed-pressure turbines.

A patent engine counter, made by Hannan & Buchanan, 75 Robertson street, Glasgow, is the subject of illustrated folders which this company is distributing. "There have been so many complaints with engine counters giving trouble that a reliable instrument has been found necessary. Engine counters, fitted with pawl and escapement wheel movement, are liable to break down at any moment through the pawl striking on the escapement wheel, when the engine is reversing or not at full stroke. Various devices have been contrived to overcome this defect, but without any satisfactory results. Buchanan's patent overcomes this defect by doing away with the pawl and escapement wheel, and by introducing a new motion on the units wheel, which turns up the figures full with the up-stroke, instead of the half figures with the down-stroke and the other half with the up-stroke, as in the Harding system engine counter. Another important improvement in Buchanan's patent engine counter is on the wheels, which are made of solid brass, engraved in block figures, filled with black wax and silvered, so that they are easily observed. In other styles with enamel figures, they are apt to get chipped; also porcelain wheels very soon get discolored with oil and crack by heat."

The Bell Rock Belting Company, Salford, Manchester, have issued a price list of their beltings, which include balata, cotton duck, hair, "Robert Stevenson" belting for wet drives, "Dreadnought" compound, and other types of belting.

The latest catalogue published by Bateman's Machine Tool Company, Ltd., Balm Road, Hunslet, Leeds, deals with the Bateman planer from the investment point of view, demonstrating the relatively small cost of a Bateman equipment capable of dealing with a given quantity of work, the economy of such equipment in running expense account, and the capacity of the machine for reducing cost of planing and subsequent labor.

A catalogue of asbestos sectional steam pipe and boiler coverings has been issued by Matthew Keenan & Company, Ltd., 80 Great Wellington street, Glasgow. The catalogue states that experience has demonstrated that Keenan coverings will save their cost in coal expenses within one year, and that in many instances they have paid for themselves within three or four months; that not only do the coverings lessen the coal bill but that they add to the capacity of the steam plant, prolong the life of the engine cylinders and reduce the temperature in boiler and engine rooms.

Messrs. Vaughan & Son, Ltd., West Gorton, Manchester, have lately published a well printed and illustrated catalogue referring to overhead traveling cranes. This catalogue, which deals with modern electric and hand-power cranes, is well illustrated. A 125-ton four-motor crane, of 51 feet span, at the Openshaw works of Sir W. G. Armstrong, Whitworth & Company, Ltd.; two 90-ton and other large cranes at the works of the North British Locomotive Company, and others in use in steel works, railway shops, etc., are illustrated and described.

Johnson & Phillips, Ltd., Charlton, Kent. Two price lists have lately been issued. One, dealing with continuous-current motors and starters, gives prices for protected, ventilated and enclosed type motors, either series, shunt or compound wound for 100, 220 and 440 volts, and the list also gives prices and armatures. Shipping specifications are also given for each size of motor. The other is a price list dealing with the various materials required by electrical contractors and engineers who have to handle cables.

Nettlefold & Sons, Ltd., 54 High Holborn, London, W. C. A little booklet dealing with the "Schroeder" ratchet spanner and box-spanner sets has been issued. The booklet contains some good illustrations, showing the advantage of spanners of this type.

The Magnolia Anti-Friction Metal Company of Great Britain, Ltd., 49 Queen Victoria street, London, E. C., have issued a small booklet dealing with magnolia metal for bearings, etc. The booklet contains testimonials, results of tests and a number of illustrations showing bearings, etc., lined with magnolia metal. Some useful metrical and English conversion tables, etc., are also included.

The Combination Metallic Packing Company, Ltd., Gateshead-on-Tyne. This company have recently issued lists giving particulars and illustrations of its metallic packing and jointing rings. One booklet gives a long list of ships of various navies fitted with their packing, and there is also a long list of shipowners who have been supplied with packing by the company.

The screw cutting and boring lathe, illustrated and described in circulars distributed by John W. Perkin, Lord street works, Leeds, is said to have special points of advantage, as it is absolutely rigid, very powerful, the screw accurate and protected from dirt and chips, and all gears are machine cut. The manufacturer states that the lathe may be returned at any time within two weeks should any defect be found, in which case all money paid, plus carriage both ways, will be refunded.

A patent portable hydraulic bolt forcer for screw propeller shafts is described in illustrated circulars published by Youngs, Ryland street works, Birmingham, England. The statement is made that the projecting ram in this device is sufficient to force a rusted-in bolt from its seat without difficulty and without damage. The principal use for this bolt forcer is for forcing in and out coupling bolts, but it is also suitable for various other purposes, such as forcing pins in and out of machines, and removing drums from the shafts of winches when fitted with a special cross-head and bolts. The novelty of the invention consists in having a hollow steel sliding ram, the ends or tails of which project through the front and back, respectively, of the cylinder.

F. McNeill & Company, Lamb's Passage, Bunhill Row, London, E. C. A catalogue concerning the company's patented slag wool, which is used a great deal for cold storage insulation, fireproofing, etc. The catalogue is divided into sections, and gives detailed drawings, showing the methods of application for various purposes.

"The Very Last Word on Chains" is the title of a pamphlet issued by the Weldless Chain Company, Ltd., Gartsherrie, Coatbridge. This booklet describes their chains, giving tests to which they may be subjected, etc. Reproductions from photographs show the excellent results of severe tests on links, hooks, etc.

Remote control switches form the subject of a pamphlet sent to us by Messrs .A. Emanuel & Sons, Ltd., George street, Manchester Square, W., who are agents for these appliances on Blackmore's patents for England. The switches may be operated from any number of positions, the control push working the switch alternately to the "on" or "off" position. Current is used only for the moment while the push is pressed.

Messrs. Ransomes & Rapier, Ltd., 32 Victoria street, S. W., have sent us a catalogue dealing with the R. & R. ice-making and refrigerating machinery. The installations dealt with in this catalogue, many of them of large size, are on the American absorption system, and worked by exhaust steam from existing steam-power plant. The system is equally adaptable to ice manufacture or to cold-storage plants.

Swan, Hunter & Wigham Richardson, Ltd., Wallsend-on-Tyne, have issued a handsome cloth-bound book on floating dry-docks. There are many beautiful lithographed cuts illustrating dry-docks built by this firm in all parts of the world. A history is given of the development of floating docks and a detailed description of the various types built and of the uses to which they are put.

A pamphlet entitled "Thermotanks," from the Thermotank Ventilating Company, 55 West Regent street, Glasgow, deals fully with the subject of the heating, cooling and ventilating of ships. The system is mechanical, electrically-driven fans being employed to circulate air warmed by passing through a heater or cooler. Two recent installations have been on the *Lusitania* and *Mauretania*.

J. Bagshaw & Sons. Ltd., Batley. A price list has been issued by this firm dealing with wrought iron pulleys, also cast iron pulleys for rope and belt driving.

J. H. Holmes & Company, Portland Road, Newcastle-upon-Tyne, have recently issued a list dealing with electric light fittings which have been designed almost entirely to meet the requirements on board all classes of ships, in workshops, factories, etc.

William Beardmore & Company, Ltd., Naval Construction Works, Dalmuir, N. B., have issued an interesting little pamphlet dealing with Peck oil engines. These engines use ordinary paraffin or petroleum, and they are claimed to be particularly suitable for marine propulsion.

Messrs. Heenan & Froude, Ltd., engineers, Worcester, issues a catalogue describing the Foster superheater, of which they are the sole makers outside of the United States of America. It contains a number of illustrations showing the application of the superheater.

A catalogue from Messrs. Smith & Grace, Ltd., Thrapston, deals with pulleys, shafting, bearings and other transmission accessories. The number of sizes and patterns of different things listed in this catalogue is very large, and prices are given throughout, rendering it quite a useful compilation.

The British Gas Furnace & Tool Company, Ltd., Globe Works, Thrope street, Birmingham, are issuing a booklet dealing with their furnaces for the treatment of high-speed steel. The outfit includes a preheating furnace, a finishing furnace, a blower and an oil tank. Two sizes are made.

Messrs. John Hetherington & Sons, Ltd., Ancoats Works, Manchester, have recently issued a catalogue containing descriptions of the machine tools exhibited at the Franco-British Exhibition. The tools include lathes, radial drills, universal milling machines, vertical mill and boring machines, etc.

Messrs. Milton & Company, Hope Iron Works, Arundel street, Halifax, are issuing a small booklet dealing with Macfarlane & Reid's self-oiling pulley blocks, which they now manufacture. Blocks of various patterns for chains, wire and manilla ropes are illustrated, as well as their several component parts.

BUSINESS NOTES

AMERICA

THE UNITED STATES ARMY has just placed in commission the second of the two gigantic hydraulic dredges required for service in the Gulf of Mexico. A noticeable feature of both of these boats, *General C. B. Comstock* and *Galveston,* is the fuel. Oil is used as the only fuel, the entire equipment being furnished by Tate, Jones & Company. Inc., Pittsburg, Pa., makers of "Kirkwood" burners. The *Galveston* is of 2,000 indicated horsepower capacity, four boilers being required. This ship was built after a thorough test of the *General C. B. Comstock,* built some six years ago, and also equipped entirely by Tate, Jones & Company. The advantages found by the government are economy in fuel cost, labor, space and time, greater mileage, lightness, and perfect control over the fire.

MARINE GAS PRODUCERS.—Great interest has been shown by the marine public for the past few years in the development of marine producer gas power. The demand for larger internal combustion motors and the increasing cost of gasoline, indicate that a cheaper fuel must be used in the larger engines. Considerable work has been done in the marine producer gas power field with anthracite fuels, but the absolute restriction of marine gas power to this fuel would seriously limit its application. An interesting and valuable contribution to the work already done in the field of marine gas power is the application of the widely-known Loomis-Pettibone bituminous gas generating system to marine service. Plants of this system aggregating over 300,000 horsepower has been installed for stationary service during the last twenty years. A recent report of a committee of the National Electric Light Association gave a list of power gas producer plants of over 300 horsepower in operation in the United States, of which 93 percent were of the Loomis-Pettibone type, and nearly all of them operated on bituminous coal, wood or lignite. The Marine Producer Gas Power Company, of No. 2 Rector street, Mr. Hawley Pettibone, president; Mr. C. Lee Straub, vice-president and general manager; Mr. W. R. Fuller, secretary and treasurer, has been incorporated for the purpose of manufacturing the Loomis-Pettibone type of gas generating plants for marine service.

THE INDEPENDENT PNEUMATIC TOOL COMPANY, First National Bank building, Chicago, Ill., writes us that its business during the month of October showed an increase of 25 percent over any other month in 1908 up to that time. A great many orders were received from railroads, machine shops, boiler and iron works and foundries, as well as an unusually large number of inquiries.

THE NEW LIFE-SAVING TUG *Snohomish*, constructed for service in the rough seas of the Pacific Coast in the vicinity of Neah Bay, has been added to the United States revenue cutter fleet. She is to be equipped with the Spencer Miller marine breeches buoy for life saving. Many times every year wrecks occur in seas so temptestuous that no boat of any sort can approach the wreck near enough to take off the endangered persons. When close enough to shore, the regular old-fashioned breeches buoy apparatus is employed with remarkable results In a single year, in United States waters alone, 189 persons were saved from wrecks by this reliable apparatus. The need of some device which would carry passengers from a wreck to a rescuing ship and maintain communication has been felt for many years. The Life-Saving Service not only of our government but that of others has been seeking for just such a device. The United States Revenue Cutter Service invited the Lidgerwood Manufacturing Company to submit a study for a small-sized marine cableway capable of carrying passengers between a wreck and a rescuing ship, not only in the open sea, but also along our coasts. The Spencer Miller marine breeches buoy is the result. The apparatus has been constructed and received its preliminary tests. The tests have established its practicability. The *Snohomish* and her life-saving appliances are for service where there is no life service station on the shore, or the wreck lies beyond the reach of the shot line and amid seas in which no small boat could live. In such instances, staunch vessels have often been able to approach wrecks but for lack of proper apparatus were unable to give help. In some instances, shot lines were sent aboard and cables made fast, but before any one could be saved the pitching and tossing of the vessels parted the lines and rendered the attempts futile. Similar conditions have often made it impossible for vessels at sea to render help to others, and seamen and passengers have perforce been left to the wild mercies of the storm.

THE MARINE GAS PRODUCER PLANTS built by the Marine Producer Gas Power Company, 2 Rector street, New York City, are stated by the manufacturer to require only one-half the fuel bunker space, weight, boiler room and labor of the average marine steam plants of equal power. They consume no fresh water, and either anthracite coal, bituminous coal, wood or lignite may be successfully used without change in apparatus. These plants are built on the well-known Loomis-Pettibone system.

THE GROWING DEMAND FOR BIRD-ARCHER BOILER COMPOUNDS in Hawaii has made it necessary for the Bird-Archer Company to open a branch office there. The new office, which is located in suite 42, Alexander Young Hotel, Honolulu, is in charge of Mr. J. P. Lynch, an experienced marine engineer, and also an authority on boiler troubles in stationary plants. Bird-Archer compounds were first introduced into Hawaii for use in connection with the boilers on sugar plantations, a class of work which has also given them great prestige in Cuba. Mr. P. B. Bird, president of the Bird-Archer Company, who is now in Hawaii, writes that boiler feed waters on the islands are so bad that if no preventive measures are employed it becomes necessary to remove scale by antiquated mechanical methods at least once every thirty days. The use of properly prepared compounds, therefore, effects a very noticeable saving in labor, fuel repairs, etc.

THE CUBAN DEMAND for non-fluid oils has grown to such an extent that the New York & New Jersey Lubricant Company, 14 Church street, New York City, has decided to place a stock of various grades with agents in every town of any size on the island. Mr. W. F. Kimball, vice-president of the company, has just gone to Cuba to facilitate the arrangements. Messrs. James B. Clow & Company, Obispo 36, Havana, the largest Cuban importers of engineering supplies, are to act as distributors, and Mr. W. N. Anderson, who is well-known among Cuban buyers, will give his personal attention to all inquiries for their products. Non-fluid oils, according to the manufacturer, first attracted attention through their ability to lubricate fully as well as the finest fluid mineral oils, and without dripping to waste, like ordinary oils, and without retarding the bearings as do greases. The dripless consistency is obtained by condensing pure lubricating elements, instead of thickening with fats, waxes, talc, resin or graphite, as in greases

A LARGE VALVE ORDER.—The Isthmian Canal Commission, which recently invited bids for a large quantity of bronze globe and angle valves, fitted with seats and discs that were capable of being renewed, has placed an order comprising more than 7,000 valves, in sizes from ¼ to 3 inches, with the Lunkenheimer Company, Cincinnati, Ohio. The valves ordered are this company's "Renewo" renewable seat and disc regrinding valves, which the maker states are practically indestructible, as every part that is subjected to any particular wear may be easily, quickly and cheaply renewed. They are guaranteed for 200 pounds working pressure.

THE BLACKBURN SMITH FEED-WATER FILTER AND GREASE EXTRACTOR has been chosen for the new colliers *Mars, Hector* and *Vulcan,* now building for the United States navy by the Maryland Steel Company. These ships have the highest class of equipment and every possible protection. The filters are to be placed in the feed lines, so that every drop of water entering the boilers is subjected to the double filtration characteristic of the Blackburn Smith filter. It is figured that by removing the oil and grease particles from the condensation the filters will repay their cost in a short time by decreasing boiler repairs and increasing fuel economy. These filters are also said to be excellent for protecting the boiler of stationary plants from floating particles of oil, grease, mud, etc., in the feed water. They are made by James Beggs & Company, 111 Liberty street, New York, who are distributing an interesting booklet on feed-water filtration.

BLOW-OFF VALVES ON 30 DAYS' TRIAL.—The "Everlasting" blow-off valve made by the Scully Steel & Iron Company, Chicago, Ill., is said by the manufacturer to be the latest and most approved device for the blow-off service, and to be different from other valves. It is claimed that it lasts as long as the boiler; that it stays tight as long as it lasts; that it will discharge scale or sediment of any character without wearing or leaking; that it can be opened gradually or all at once, according to your regulations; that it has straight-through and uninterrupted discharge; that it has no stuffing-box and works very easily. The Scully Steel & Iron Company does not ask anyone to take these statements as the truth without trial, but will send one of these valves on trial, thirty days, free. If you don't like it you can send it back at the company's expense. The Scully Company will also send any one interested, who will mention INTERNATIONAL MARINE ENGINEERING, a free copy of its 144-page monthly stock list.

RECENT ORDERS FOR NICHOLSON SHIP LOGS.—Barrett & Lawrence, 662 Bullitt building, Philadelphia, Pa., Eastern agents of the Nicholson Ship Log Company, have received contracts to equip the United States battleships *New Hampshire, Montana* and *North Carolina* with No. 1 Nicholson logs. This makes a total of eight battleships and cruisers of the United States navy that have been equipped with this log since last June. The cruisers *Idaho, Chester* and *Salem* have already been so equipped, and the *Utah* and *Florida* are also to be fitted. In addition, Barrett & Lawrence have just received a contract to furnish a log for the steam yacht *Alcedo,* owned by Mr. Drexel, of Philadelphia. The maker of these logs states that they are the only ones built which will indicate the speed of a vessel and count the knots run, thus furnishing a valuable means of checking the coal consumption and enabling the engineer to maintain a uniform speed.

THE GRISCOM-SPENCER COMPANY, 90 West street, New York City, wishes to make public the excellent facilities afforded by its general machine and boiler works, operating in conjunction with an engineering and contracting department consisting of a staff of competent mechanical engineers, for the development, design and manufacture of special machinery; boiler, engine and machinery installation and repair; shipbuilding and repairing, and furnishing tools and supplies of every description. The manufacturing and repair shops have the following facilities: Machine, boiler, carpenter, pipe cutting, coppersmith and electrical repair shops; foundry for iron, brass, bronze, hydraulic metal and composition castings. Repairs are made day and night, Sundays and holidays, if necessary. Among the specialties manufactured in the shops of this company are the Reilly multi-coil feed-water heater, the Reilly evaporator apparatus and the Ebsen filter and grease extractor. The company is also agent for the Russell Engineering Company and for the Tudor Boiler Company, and for other power-plant equipment concerns.

THE BABCOCK & WILCOX COMPANY has purchased from the Rust Boiler Company its patents and plant located at Midland, Pa., and will continue the manufacture, at that point, of the Rust watertube boiler.

BOILERS IN THE *Asbury Park*.—The Roberts Safety Watertube Boiler Company, Red Bank, N. J., writes us regarding certain statements circulated that the Roberts boilers in that steamer have been giving trouble. The company states that they made an investigation regarding these statements, and finds that these are absolutely false, that the boilers in question gave even more satisfaction this year than during either of the two previous successful seasons, that they made more than enough steam, which is not only absolutely dry, but slighty superheated, and all the time with natural draft only.

BUSINESS NOTES

GREAT BRITAIN

MESSRS. S. T. TAYLOR & SONS have covered boilers, pipes, etc., of the steamships *Hildago, Triton* and *Mina* with their "Tynos" non-conducting material. Covered cylinders of steamship *Ottar* with their "Tynos" non-conducting material. Covered boilers, pipes, etc., of steamships *Fangturm* and *Bedonia* with their "Tynos" non-conducting material, and boiler bottoms with their "Tynos" patent removable asbestos mattresses, and very extensive covering work on H. M. S. *Invincible,* at Elswick shipyard. Also boilers, etc., of steamships *Conqueror, Paris* and *Oneida.*

A CONTRACT has been secured by Messrs. James Howden & Company, Glasgow, for a turbo-generator set of engines for the Corporation of Manchester. Seven tenders were considered by the corporation—four for turbines of the Parsons type and three for the Zoelly type. The Zoelly turbine has made great progress in recent years in France, Germany, Austria and other Continental countries, and though more expensive to construct than the Parsons, it is claimed as more economical, especially in working below full power, than any other turbine, a matter of much importance in these machines where the output of electricity varies so greatly during the hours of the day in which they work. Messrs. Howden & Company have made the largest turbine of this type at work in this country—one of 2,000 kilowatts, or 3,000 B. H. P., at the Powell-Duffryn Collieries, at Aberaman, in South Wales. This turbine has proved so satisfactory in its working that the company have given Messrs. Howden a repeat order for this Zoelly turbine, which they have now under construction. The Howden-Zoelly turbine which the firm are to construct for Manchester will be 6,000 kilowatts—larger than any Zoelly turbine now working, and larger, it is believed, than any turbine yet installed in this country for generating electricity, with the exception of one of the same power (6,000 kilowatts) of the Parsons type recently installed by the Manchester Corporation. Messrs. Howden have, it is understood, guaranteed a lower consumption of steam with the Howden-Zoelly system, and have undertaken to deliver the new turbine in less time than any other maker. The contract includes the generator, which is a Siemens alternator, and a condensing plant, which is on the Contraflo patent.

TRIAL TRIP OF NEW STEAMER *Haiyang*.—The new passenger and cargo steamer *Haiyang,* recently launched by Messrs. David J. Dunlop & Company Inch Works, for the Douglas Steamship Company, of Hong Kong, after completing her fitting out at the builder's dock and having loaded 2,500 tons of coal, etc. (for trial deadweight), at the James Watt dock, proceeded to the measured mile at Skelmorlie on Sept. 3 to undergo her official speed trials. On the invitation of the builders a large company of guests were conveyed by tender from Gourock pier, about 10 o'clock, to join the new steamer. The *Haiyang* is of the following dimensions: Length between perpendiculars, 300 feet 6 inches; breadth, moulded, 38 feet; depth moulded to spar deck, 25 feet; gross tonnage, 2,289 tons. Her propelling machinery consists of one set of triple expansion engines, designed and fitted by the builders, having cylinders 21½ inches, 35 inches and 57 inches diameter by 39 inches length of stroke, steam being provided by two multi-tubular boilers, 14 feet 6 inches diameter by 10 feet 8 inches long, all proportioned for a working pressure of 180 pounds per square inch, and in addition a large donkey boiler is fitted for working all deck machinery, including winches, windlass, electric lighting, etc. The hull and machinery have been built under Lloyd's and Board of Trade special survey for their highest class as a spar-deck steamer with foreign-going passenger certificate, all the requirements having been adopted.

CONRAD LAUER & COMPANY have started business as boiler and steam pipe coverers, at 65 Euston Road, London, N. W. Mr. Conrad Lauer has been associated with Messrs. A. Haacke & Company, of Homerton, for the last twenty-five years, which business has been converted into a limited company, but Mr. Lauer has now no connection with the new concern, having severed his connection entirely. Mr. George Cross has left the employment of Messrs. A. Haacke & Company, Ltd., Homerton, and is now representing Messrs. Conrad Lauer & Company.

ADMIRALTY ORDERS.—Orders for new second-class cruisers of the *Boadicea* type have been placed with Messrs. Beardmore & Company, Vickers, Sons & Maxim, Sir W. G. Armstrong, Whitworth & Company, the Fairfield Company, and John Brown & Company. Each firm named will build one cruiser. The speed is to be 26 knots and the engine horsepower 22,000. The lowest accepted tender for any one of these cruisers was about £292,000, and the highest slightly over £300,000. Seven more destroyers have also been ordered quite recently, J. S. White & Company, of Cowes, getting two and the following firms one each: Hawthorn, Leslie & Company, J. Thornycroft & Company, Beardmore & Company, Denny Bros., and the London & Glasgow Engineering & Iron Shipbuilding Company. Some months ago, it will be recalled, an order for nine 27-knot destroyers was divided between Cammell, Laird & Company, the Fairfield Company and John Brown & Company. We understand that the penalty clauses in the new contract are extremely severe. It is reported that no less than £9,000 will be forfeited if the speed on the reliability trials is less by 1 knot than the contract speed and £20,000 if the deficit falls to 2 knots. The price of these boats is about £110,000 each, which is considerably more than the cost of the first nine, which were placed for £900,000, some being as low as £97,000 each. The severe penalty clause mentioned above accounts probably, in part at least, for the diffence. It will be noticed that the bulk of the orders have gone to Scotland, and that the Tyne has come off but poorly. Probably the Tyne quotations were higher than those of the Clyde. The Tyne hopes to get the order for some of the turbine machinery for dock-yard cruisers and battleships.

ELECTRICITY ON STEAMSHIPS.—Messrs. W. C. Martin & Company, electrical engineers, Glasgow, London and Newcastle, have, notwithstanding the dullness of trade, had a fairly busy year. They specialize in steamship installations, and this year have turned out an average of one complete installation per fortnight. Among the ships fitted this year may be mentioned the *Hesperian,* for the Allan Line; *Royal Prince,* for Prince Line; *Ancona* and *Verona,* for Italia Societa De Navigazione a Vapore, Genoa; *Elysia,* for Anchor Line; *Makura,* for Union Steam Ship Company, of New Zealand; *Mourilyan,* for Howard, Smith & Company; *Koombana,* for Adelaide Steam Ship Company; *Tamarac, Cadillac* and *Oneida,* for the Anglo-American Oil Company; *Bellaventure* and *Bonaventure,* for A. Harvie & Company, St. Johns, Newfoundland; *Richard Welford,* for the Tyne & Tees Shipping Company; *Courchan,* for Union Steam Ship Company, of British Columbia; *Acadian,* for Mutual Steam Ship Company, of Sydney; *Bellambi,* for Bellambi Coal Company, of Sydney; *Boulah,* for Wallarah Coal Company, of Sydney, and several special boats for the Suez Canal Company. It is interesting to note that electric radiators and cooking utensils are coming greatly into favor on board ship. In fact, electric appliances are being adopted so largely that in the near future they will use more electricity for this purpose than is at present used for lighting. Some of the applications of electric power this year are as follows: Hot plates for use in galleys, pantries or in saloons and pantries. Water and milk heaters for use in pantries and in stewardesses' rooms, enabling the stewardess to attend to the wants of the children and others in the night time. It is now customary to fit a laundry on passenger vessels, and here electric motors drive the washing, drying and ironing machines, while the electric current supplies the every-ready hand-smoothing iron. Electric lifts for passengers, pantry service and stores are being largely fitted, and are greatly appreciated by passengers and crew alike. The use of electricity for heating and cooking marks a great advance in the comfort and appearance of a ship's accommodation. The absence of steam-heating pipes improves the appearance of corridors, and makes the cost of up-keep for painting, etc., much less. A large installation of arc lamps has also been completed at Rothesay Dock, Clydebank, for the Clyde Trust. Messrs. Martin enter the new year with a number of large contracts in hand, among which are three of the new Orient liners, a passenger steamer for Messrs. Koninklijke Maatschappij, *De Schelde,* Vlissengen, and a large ferry steamer for trains and passengers for the Swedish State Railways.

MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.
314 Madison Avenue, New York City.

UNITED STATES NAVAL INSTITUTE.
Naval Academy, Annapolis, Md.

GREAT BRITAIN.

INSTITUTION OF NAVAL ARCHITECTS.
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.
207 Bath Street, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.
St. Nicholas Building, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

GERMANY.

SCHIFFBAUTECHNISCHE GESELLSCHAFT.
Technische Hochschule, Charlottenburg.

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CORRUGATED AND RINGED FILTERS for preventing oil and grease entering boilers, for purifying feet-water, and for many other purposes, are made by Willock, Reid & Company, Ltd., 109 Hope street, Glasgow. Among the many users of these filters are the White Star Line, the Pacific Steam Navigation Company and the West India Line.

THE PHOSPHOR BRONZE COMPANY, LTD., Southwark, London, S. E., in calling attention to its "Cog-Wheel" brand of phosphor bronze, which is cold-rolled and drawn, states that it is a genuine bronze, free from zinc, iron, manganese, aluminum or other alloys; that it is tough as iron, strong as steel, and offers a maximum resistance to corrosion. This bronze is stated to be especially valuable for pinions, valves, high-pressure steam and boiler fittings, pumps, propellers, stem and stern posts, etc.

FRANCO-BRITISH EXHIBITION AWARDS.—A gold medal has been awarded to Messrs. Bergtheil & Young, Ltd., Camomile street, London, E. C., at the Franco-British Exhibition for their new patent electric punkah. This is the only gold medal which has hitherto been given for a mechanical punkah. Messrs. Bergtheil & Young, Ltd., tell us that they are negotiating with the best-known shipping companies in connection with the installation of their punkahs in the saloons, etc., of the larger steamships.

THE NORWEGIAN MOTOR SCHOONER *Saevereid* recently arrived at Yarmouth with 350 tons of granite setts. This vessel is fitted with a paraffin engine capable of giving her a speed of 5 knots when loaded, the object of the engine being to propel the vessel during calms, or against head winds. The cargo winch is also motor-driven by a separate engine. The *Saevareid* has been especially constructed to ascertain the value of auxiliary oil motors for North Sea trading vessels.

CARR BROS., LTD., 11 Queen Victoria street, London, E. C., write us that they have been appointed the sole European agents of the Peerless Rubber Manufacturing Company.

MESSRS. LANCASTER & TONGE, LTD., makers of the Lancaster pistons, steam traps and metallic packings, are making large additions to their works in order to meet the increasing demands for their specialties.

ASPINALL'S PATENT GOVERNOR COMPANY, Liverpool, has been awarded a diploma for a gold medal for their patent marine engine governors at the Franco-British Exhibition, London.

MESSRS. SMALL & PARKES, LTD., of Hendham Vale Works, Harpurhey, Manchester, have been awarded a gold medal at the Franco-British Exhibition for their "Karmal" packing and "Roko" belting.

MR. S. ALEXANDER FOX, Assoc. M. I. M. E., has joined the board of directors of W. Sisson & Company, Ltd., and will continue to be responsible for the technical work of the company. Their high-speed, enclosed, self-lubricating engines and marine machinery are well known.

MESSRS. WILLIAM BEARDMORE & COMPANY, LTD., Glasgow, have been awarded a diploma for the grand prize for steel boiler plates, steel material, armor plates, Peck oil engine, merchant steamers and warships at the Franco-British Exhibition, London.

THE BRITISH PETROLEUM COMPANY, LTD., have erected storage tanks capable of holding from 10,000 to 50,000 tons of oil fuel at all the chief ports and manufacturing centers, such as London, Manchester, Newcastle-on-Tyne, Barrow-in-Furness, etc.

MESSRS. WILLIAM SIMMS & COMPANY, LTD., engineers, ship and dredge builders, Renfrew, have been awarded the Grand Prize by the International Jury of the Franco-British Exhibition for their exhibit of dredge plant and elevating deck-ferry steamers.

MESSRS. W. C. MARTIN & COMPANY, the well-known electrical engineers, of West Campbell street, Glasgow, who installed the electric lighting apparatus in the *Mauretania*, have secured the lighting contract for three of the five new Orient Company's liners.

PETER HOOKER, LTD., have purchased the Newall Engineering Company's business at Warrington, together with the entire plant and good will of that company's business in limit gages, measuring machines and other products, and will continue it as a department of their business under the name of the Newall Engineering Company, at Walthamstow, London, E.

THE AUTOMATIC WASTE OIL FILTER made by the Valor Company, Ltd., Rocky Lane, Aston Cross, Birmingham, is stated by the manufacturer to be the best and most effective filter on the market, and that it thoroughly cleanses dirty oil so that it can be reused, thus effecting an enormous saving in oil bills.

S. A. WARD & COMPANY, engineers, Broad street lane, Sheffield, are distributing circulars describing and illustrating their equilibrium piston rings, which they state are suitable for all pressures and speeds. Among the special features claimed in the combination of these rings is that while they are free to adjust themselves to any slight wear, either outward or laterally, the outward pressure of the strong spring ring is held in check by two undivided or solid bevelled rings.

MERRYWEATHER & SONS have just constructed a petrol motor fire boat for the Buenos Ayres & Southern Dock Company. The pumps, which have a total capacity of 700 gallons per minute, are driven by two petrol engines, each 55-brake horsepower, whilst the propulsion of the boat is effected by means of hydraulic jets at sides, delivered from the fire pump. The pumps discharge through six outlets on deck, or their entire power can be delivered through a monitor in one large jet. The vessel can also be used for salvage operations, a suction connection being provided for this purpose.

THE FIRM OF WAILES, DOVE & COMPANY, LTD., who exhibit at the Palace of Machinery, Stand No. 337, of the Franco-British Exhibition, their patent "Bitumastic" enamels, as applied to the ships of the British and foreign admiralties, the mercantile marine throughout the world, and to the plant of the chief industrial concerns, railways and municipal corporations in the United Kingdom, have been awarded two diplomas of the highest merit with gold medals, in classes referring to the mercantile marine and civil engineering, respectively. This firm also received gold medals at Genoa 1905, Milan 1906, Savona 1906, and Bordeaux 1907, for superiority of the anti-corrosive qualities of their patent "Bitumastic" enamels, covering and solution.

TRADE PUBLICATIONS.
AMERICA

Brass and bronze engine fittings and special castings of every description form the subject of a 64-page illustrated catalogue just issued by the Norwalk Brass Company, Norwalk, Conn. This company makes a specialty of propeller wheels, and states that its long experience in making these wheels enables it to select the style of blade most suitable for a given purpose. All diameters and every pitch are made. A number of diagrams are given, showing experimental model basin details of propeller blades used in experiments on the effect of the shape of blades. The propeller fitted to the *Dixie II.*, which is said to be the fastest boat in the world, was made by the Norwalk Brass Works.

The "Record of American and Foreign Shipping," for 1909, American Lloyds, which is the forty-first annual issue of this valuable register and classification of shipping, is now being delivered to subscribers. The *Record* contains full reports and particulars of about 16,000 vessels of all classes and nationalities; rules for the construction and classification of iron, steel and wooden vessels; rules for the construction and survey of steam machinery and boilers for vessels; provisions for the installation of electric lighting and power apparatus on shipboard, and much other valuable information of special importance to underwriters and all firms or persons interested in shipping. Besides the usual full information for the benefit of subscribers in the way of rules for construction, with their accompanying illustrations and tables, all of the utmost practicable and technical value, the work contains such features as list of addresses of prominent shipbuilders, drydocks, marine railways, marine machinery and boiler constructors in the United States; list of vessels whose names have been changed; also compound names indexed as per last name; names and addresses of owners of vessels classed in the *Record*, all of which is nowhere else so completely classified. This record of shipping is said to be the only book now published containing reports and particulars of all American vessels. The work is approved and endorsed by the important boards of underwriters in the United States, and is accepted by underwriters and merchants throughout the world as a standard register and classification of shipping. The new *Record* is published by the American Bureau of Shipping, 66-70 Beaver street, New York.

Condulets are described and profusely illustrated in a large catalogue of 80 pages published by the Crouse-Hinds Company, Syracuse, N. Y.

Buffalo Gasolene Motor Company, Buffalo, N. Y., manufacturer of Buffalo marine engines, had a very comprehensive and attractive exhibit at the Motor Boat Show at Boston. In addition to several various sizes of regular and heavy-duty types, the company exhibited a new model high-speed machine, which is claimed by the manufacturer to represent the most up-to-date and highest grade piece of marine engine construction on the market to-day. In getting out this new machine the above-mentioned firm states that it has adhered to all the good principles and features of its former models, and also included a number of new and distinct improvements and ideas. These machines are built in four and six-cylinder, 50 and 75-horsepower, 6¼ by 6¾—the last-mentioned size being exhibited at Boston. They are very compact machines, with low center of gravity; an important consideration for a speed boat, fitted with all modern improvements, such as force feed lubricators, double system of ignition, *i. e.*, Bosch magneto, direct connected, and timed with engine and regular coil and battery system, a positive locking clutch in connection with regular friction clutch, rocker-arm construction for valve lifters and many other minor features. Although on the market only a short time, already a large number have been sold and many other sales are in prospect. In addition to this machine, this company exhibited the following: In its regular medium-weight, medium-speed machines, a 3-horsepower, two-cylinder; a 10-horsepower, four-cylinder, a 20-horsepower, four-cylinder, and in their high-powered machines a 65-horsepower, four-cylinder machine, this machine differing in construction from any of their other models. In the slow-speed, heavy-duty type the company is exhibiting a new size 4-horsepower, single-cylinder engine, which has recently been placed on the market, and which is very popular for auxiliary work and for heavy class of boats where a small powered and absolutely reliable engine is required, a 12-horsepower, two-cylinder, and a 36-horsepower, four-cylinder. The company had many other articles and fittings in connection with its business on exhibition. The Buffalo Gasolene Motor Company will exhibit at the New York show, and at Buffalo, Toronto and Detroit.

Foundry machinery and equipment is the subject of booklet 93 issued by the Northern Engineering Works, Detroit, Mich. This company designs and equips complete foundry plants, and the booklet is a reminder of what the company makes in the line of foundry machinery. Larger catalogues and bulletins are issued, giving full particulars of every class, and these will be sent free upon request.

"A History of the Seamless, Cold-Drawn Steel Tube Industry in America" is published in pamphlet form by the Ohio Seamless Tube Company, Shelby, Ohio. A free copy of this pamphlet will be sent to any reader mentioning this magazine.

Detroit steam traps, tilted tank type, Detroit return trap system for boiler feed and water lift, are the subject of pamphlet No. 247 published by the American Blower Company, Detroit, Mich. This return trap is a device for receiving the water of condensation from whatever source, and automatically delivering it into the boiler at practically the temperature at which the steam is condensed.

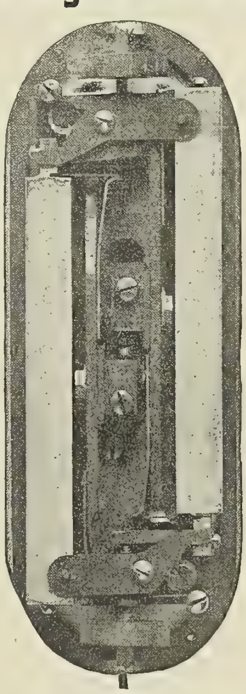
"Shop Heating; a Treatise Containing Practical Suggestions," by F. R. Still, has been published in pamphlet form by the American Blower Company, Detroit, Mich. This pamphlet is beautifully printed and illustrated, like all publications issued by the American Blower Company. A free copy will be sent to any reader mentioning this magazine.

Lumen bronze die castings are described in a booklet published by the Lumen Bearing Company, Buffalo, N. Y. The claim is made that Lumen bronze opens up a new field for die parts, as with a compressive strength of 80,0000 pounds per square inch claimed, a tensile strength of 35,000 pounds, a torsional strength of 35,000 pounds, and electric conductivity, said to be equal to that of high brass, it enables the company to offer a metal from which bearing parts may be cast in this form.

The Quincy forge of the Fore River Shipbuilding Company, Quincy, Mass., is the subject of a handsomely illustrated booklet published by the above company, which solicits forging orders and will send prices on application. Photographs forges and also photographs of some of the company's are shown of the machinery and tools in this company's product, such as tug forgings, stern frame forgings and rudder frames. Special attention is called to a specimen of difficult forging, illustrated. This is a six-throw, one-piece, hollow bored, nickel-steel crank shaft for a 250-horsepower gasoline engine. Work of this nature requires absolute accuracy.

Steam and oil separators are described in a catalogue published by the Pittsburg Gage & Supply Company, Pittsburg, Pa. Among the advantages claimed for separation are: "Besides affording protection against accident, the separator has other advantages of importance. The greatest of these in regular service is the increased efficiency due to delivery of dry steam. There is also the improved lubrication, eliminating the losses of oil, which otherwise would be swept along with the water and go to waste in the exhaust. The separator catches all grit, scale, rust, gasket fragments and other foreign matter which may be carried along by the steam. Separators have been known to receive nuts, bolts, and even wrenches left in the piping system by careless workmen. Many an engine wreck has been averted in this way. A separator used before a steam turbine will be the means of eliminating the wear due to the impingement of water at high velocity on the blades. A separator is of value before a superheater, increasing its effectiveness by eliminating the retarding influence of entrained water."

Packings for surface condenser and heater tubes are described in illustrated circulars published by Joseph Allen, Collingswood, N. J. Every packing is stated to be a uniform coil of finest twisted cotton thread, and the claim is made that it outlasts the best tubes that are made. With each packing there is inserted a special flexible fiber washer, that goes next to the ferrule and prevents any slacking back. The packing and washer are inserted by one operation, and the manfacturer states that tube ends can be packed with ease at the rate of eight per minute; also that there is no danger of any leak. Tools made of fine, drawn steel, for inserting these packings, are also made by Mr. Allen, and he states that he sells them at cost price, and that with these tools ten tube ends per minute can be packed. A number of testimonial letters are reproduced from shipyards which have used these packings, among them being such concerns as the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.; the Quintard Iron Works Company, New York City. There are also similar letters from the Navy Department and from the United States Revenue Cutter Service.



Mechanism of Thermostat

A handsome pocket diary, bound in soft vellum, has been published by the Durable Wire Rope Company, 26 Atlantic avenue, Boston, Mass. This diary contains domestic and foreign postage rates, weather bureau signals, interest laws, tables of weights and measures, population of States and cities, as shown by the last census, of foreign coins, etc. A free copy will be sent to any reader who will mention International Marine Engineering.

A Valuable Gas Engine Catalogue.—A copy of the 1909 catalogue of Buffalo marine engines has just come to hand, and on looking it over its completeness and arrangement appealed to us very much. In this catalogue the Buffalo Gasolene Motor Company, Buffalo, N. Y., illustrate, list and fully describe their complete line of medium-weight, medium-speed engines; their slow-speed, heavy-duty type of engine; "the original heavy-duty machine," and their new type high-speed machine, brought out for 1909 market, and which, it is said, promises to be one of the most popular high-speed machines on the market and an engine well worthy to be sold on "Buffalo Reputation." The medium-weight, medium-speed machines, first mentioned, possess some new features said to be of great value. The improvements claimed for both the medium-speed and the heavy-duty engines for 1909 are as follows: Force-feed lubricators, gear driven; water-jacketed exhaust manifolds; rocker-arm construction for valve lifters; improved type of reverse gear, giving a much stronger and, at the same time, a much simpler clutch; double system of ignition, consisting of Bosch magneto, direct connected and timed with the engine for one system and the regular coil battery system. The above improvements are standard equipment on Buffalo engines—10 horsepower and over—henceforth. Force-feed lubricators, Bosch magneto and water-jacketed exhaust manifolds are not applied to engines smaller than 10 horsepower as standard equipment. The new high-speed engines spoken of are claimed to be thoroughly up-to-date machines in every respect. In them are embodied all the principles and good features of previous models of this company and some distinctive new improvements and good features, especially adapting them for the class of work they are designed for. These machines are built in two sizes only, four and six-cylinder, 50 and 75 horsepower, 6¼ by 6¾, according to the manufacture. They are built as light as it is possible to build an engine consistent with honest material and workmanship, and this lightweight is not obtained by sacrifice of strength in any of the vital parts. Aluminum alloy is used for base, crank chamber and journal caps and other castings where it can be used, and in many places steel forgings or steel castings are used where ordinarily gray iron is used, thereby obtaining the same, or greater, strength with less weight. The machines are complete in every detail. They are equipped with force-feed lubricators, double system of ignition, such as above described; rocker-arm construction for valve lifters, centrifugal water pump and plunger air pump and new type positive clutch, in connection with the regular friction clutch, absolutely guarding against slipping of the clutch when under way. The water jackets are ample, bearings are large and carefully fitted and well lubricated. It is said to be an engine that can be depended upon to go and keep going, to be a very smooth running machine and remarkably quiet. The catalogue also illustrates and lists a number of special outfits, such as small stationary and portable plants, worked up by the use of the heavy-duty engine, with what changes were necessary to adapt it for stationary and portable work; a very compact and powerful pumping plant, on which their regular type medium-weight engine is used, and a generating set, consisting of regular type medium-speed engine, connected to generators, both the generator and engine being mounted on one solid frame, which makes a very compact outfit and a very attractive one in every respect. The catalogue also treats upon the new device got out, rendering possible the use of kerosene as fuel for Buffalo engines. This device has been thoroughly tried out, and is said to work to perfection. When the Buffalo is fitted with this device for the use of kerosene, the cylinders and valves are claimed not to become fouled rapidly, as perfect combustion is secured. The catalogue contains 48 pages, and is profusely illustrated, not only with views of the various size engines but also some interesting photographs of boats in which Buffalo engines have been installed in various parts of the world, and concerning which there are some interesting write-ups. The catalogue is artistically arranged and printed. The Buffalo Gasolene Motor Company will be glad to mail their catalogue free to interested parties, and anyone desiring same can secure it upon request and by mentioning the name of this publication.

CALENDARS RECEIVED.

The Ashton Valve Company, 271 Franklin street, Boston, Mass., manufacturer of high-grade pop safety valves and steam gages. This company, as usual, issues an artistic calendar, showing in this case a lithographed picture of a lake in the woods, with a fair canoeist in a pink gown, which makes a striking contrast against the background of the lake and woods.

The Glasgow Iron Company, Harrison building, Philadelphia, Pa., manufacturer of flanged and pressed work of various descriptions. A large wall calendar, showing the various phases of the moon for the year.

The Star Brass Manufacturing Company, 108 Dedham street, Boston, Mass., manufacturer of pop safety valves, gages and other steam specialties. A large wall calendar with illustrations at the top of this company's products.

H. B. Underwood & Company, 1025 Hamilton street, Philadelphia, Pa., manufacturer of portable tools for railway repair shops. A large wall calendar.

The Bourne-Fuller Company, Cleveland, Ohio, dealers in iron, steel, pig iron and coke. A handsome wall calendar—jet black with white letters.

Revere Rubber Company, Boston, Mass., manufacturer of rubber packings and mechanical rubber goods of all kinds. A wall calendar lithographed in several colors.

Elisha Webb & Son Company, 136 South Front street, Philadelphia, Pa., manufacturer of and dealer in steamship equipment and supplies. A calendar giving the quarters of the moon, and a table showing the difference between the time of high water in Philadelphia and about 100 places on the United States coast.

Moran Towing & Transportation Company, 17 Battery Place, New York City. A calendar showing high and low water for every day in the year at Sandy Hook, Governors Island and Hell Gate, and a tide table showing the difference between high water in New York and a large number of ports on the Atlantic Coast, as well as on the Hudson River.

O. C. & K. R. Wilson, 78 Dey street, New York City. A calendar showing high and low water for every day in the year at Sandy Hook, Governors Island and Hell Gate, and a tide table showing the difference between high water in New York and a large number of ports on the Atlantic coast, as well as on the Hudson River.

Theo. A. Crane's Sons Company, Erie Basin, Brooklyn, N. Y. A calendar showing high and low water for every day in the year at Sandy Hook, Governors Island and Hell Gate, and a tide table showing the difference between high water in New York and a large number of ports on the Atlantic Coast, as well as on the Hudson River.

Carter's Ink Company, Boston, Mass. A small but handsome calendar, lithographed in several colors, showing a young lady driving a trap with a Boston bull dog on the seat beside her.

TRADE PUBLICATIONS

GREAT BRITAIN

The Unbreakable Pulley & Mill Gearing Company, Ltd., 56 Cannon street, London, E. C., has published a catalogue for the benefit of those who, having used this company's system of power transmission, are well acquainted with its principles, and only need a handbook of dimensions, code words and prices of the standard fittings. No pains have been spared to make it complete, so that engineers and others may work out all the details and estimate the cost of any scheme from its pages. Several useful tables of powers, strengths, etc., have been included.

A flashlight engine indicator for steam and explosion engines is the subject of an illustrated catalogue published by Dobbie McInnes, Ltd., 57 Bothwell street, Glasgow. The claim is made that by dispensing with the usual multiplying parallel motion this indicator obviates any risk of error, due to inertia of such moving parts and of mechanical imperfections, such as back lash in the transmission of the motion from the spring to the pencil. Instead of a parallel motion, which, irrespective of excellence of design and workmanship, possesses weight, and is affected more or less by wear and tear, a beam of light is employed which is reflected from a mirror, the end of which traces the indicated diagram on a glass screen engraved with scales, or on a photograph plate.

The Stern Sonneborg Oil Company, Ltd., Royal London House, Finsbury Square, has issued a catalogue dealing with oils and greases. It gives details of different kinds of lubricants suitable for all classes of machinery. Illustrations and particulars are also given of various kinds of lubricators, including Stern's Stauffer lubricator.

Electric cranes, capstans, turntables, etc., made by Cowans, Sheldon & Company, Ltd., St. Nicholas Works, Carlisle, are shown in their new illustrated list. Overhead electric cranes, overhead revolving cranes, warehouse electric cranes, wharf electric cranes, electric derrick cranes, revolving cantilever cranes, electric traveling cranes, etc., are shown to advantage.

Steam and hand windlasses are the subject of circulars published by Harfield & Company, Ltd., Arundel House, Victoria Embankment, London, W. C. This company's improved "B" design of steam engine and manual lever windlass, fitted with compound brakes and frictionless connectors and reverse action, is stated to have the following advantages over ordinary windlasses: "It is made with a foundation plate, and arranged for the cables to lead to the underside, and after passing over the windlass to pay down through pipes formed in the side standards to the chain lockers underneath. It gives the cable double the amount of hold on the windlass, which is of great importance in 'veering' or 'weighing,' particularly when the shackles are on the cable-holders with a heavy strain on the chain. The 'pull' of the cable, being in a direction parallel with the deck, has no 'tilting' or 'capsizing' effect (as in windlasses where the cable is taken over the top), and consequently there is much less strain on the deck and fastenings. These remarks apply also to the bow stoppers, which rarely require chocking up, and therefore are much less expensive to fit. The deck pipes, being in the side standards and a considerable height above the deck, are much more easily got at and made watertight than when they are under the windlass. The manual levers, being abaft the windlass, the men when working them are clear of the cables. The cables veer as freely as on windlasses where they lead over the top."

Ball bearings and steel balls, made by the Hoffmann Manufacturing Company, Ltd., Chelmsford, Essex, are described and illustrated in a handsome catalogue just published. The rings are said to be made of the very finest quality of steel, especially made for the purpose, and hardened in such a way as to secure absolute uniformity. The balls are made of a special quality of high-carbon tool steel, also especially made. They are all guaranteed to be perfect spheres and correct to standard within 1/10,000 of an inch.

Milling machines are described in a new list issued by John Holroyd & Co., Perseverance Works, Hilnrow, near Rochdale. Various types are illustrated, and a list of dimensions is given, together with other particulars relating to each class of machine. Most of the 70 pages in the list are well illustrated. We are informed that the list by no means represents all milling machines which the firm has built, but only some of the principal machines are shown.

The hydraulic steering telemotor made by Brown Bros. & Company, Ltd., Edinburgh, is the subject of an illustrated booklet which has just been published. The statement is made that when the distance between the steering engine and the position of the steering wheel is considerable, as in most modern ships, and it is desired to have connection between the steering wheel and the steering engine with as little friction as possible, that the telemotor shows to the greatest advantage over shafting and its equivalents. Full instructions are given for charging, adjusting and working, and a large plate of detailed drawings is included in the volume.

Expanded metal screens and covers for electrical plants, also expanded metal guards for ordinary machinery, are illustrated in a list from the Expanded Metal Company, York Mansion, York street, Westminster, S. W.. Switchboard end screens with doors, switchboard base panels, switchboard enclosures, doors of expanded metal—hinged or sliding—sheet steel for oil switch cells, transformer housings, resistance covers, motor starter covers, covers for ventilators, lamp protectors and panels of various shapes are shown. Expanded metal machinery guards are illustrated, in use for covering various parts of machinery, such as gear wheels, belts and other dangerous parts.

Steam yachts, launches and motor boats are the subject of a handsomely illustrated booklet issued by Isaac J. Abdela & Mitchell, Ltd., Brimscombe and Manchester. This publication consists of half-tone illustrations of light draft passenger and cargo steamers, fire boats, launches, tugs and other small craft built by this company.

Patent roller bearings are described in a catalogue published by the Empire Roller Bearings Company, Ltd., 15 Victoria street, Westminster, S. W. The claim is made that these roller bearings are of the most perfect design and durable form, and that they save about 90 percent of the loss of energy which is continuously expending in overcoming the great frictional resistance, due to the old form of fixed bearings supporting moving surfaces; also that the economy effected by a good roller bearing will at least equal that obtained by electric driving.

F. & S. ball bearings, manufactured by Fichtel & Sachs, Schwenfurt, Bavaria, sole agents for the United Kingdom and Colonies, the Tormo Manufacturing Company, 67-68 Bunhill Row, London, E. C., are described in an illustrated catalogue of 116 pages. This catalogues states that exhaustive experiments and great practical experience have taught the manufacturers to bring their ball bearings to such perfection that they are able to supply them with a full guarantee for their durability and efficiency, thus saving the users from 30 to 40 percent in power and oil. It is stated that accuracy of these bearings is correct to 1/1000 mm., thus rendering all parts interchangeable.

D. W. E. patent ball bearings are described in an illustrated catalogue issued by Lud. Loewe & Company, Ltd., 30 Farringdon Road, London, E. C. The catalogue states that the very wide application of these ball bearings affords ample proof that they are satisfactory under all conditions prevalent in general engineering practice; that for years they have been running 12,000 to 14,000 revolutions per minute, and that this figure by no means represents the limit. The catalogue also mentions, as showing their suitability for heavy work, that they have been successfully employed for the bearing of fly-wheels weighing 15 tons. They are said to be especially suitable for propellers, shafts, conveyors, electric motors, dynamos, steam turbines, ventilators and the like.

BUSINESS NOTES

AMERICA

MRS. FRANCES A. MCINTOSH, formerly advertising manager of the Buffalo Forge Company and associate companies, has resigned that position to open an office, where her services in the preparation and printing of advertising literature can be secured. Correspondence should be addressed to 103 Anderson Place, Buffalo, N. Y.

FREE.—A LARGE CAN OF GREASE, AN ENGINEER'S CAP and a fine brass grease cup. These articles will be sent absolutely without charge to any engineer who will write to Department V, the Keystone Lubricating Company, Philadelphia, Pa., mentioning that he saw the offer in INTERNATIONAL MARINE ENGINEERING.

CAPITAL VS. LABOR.—The American Blower Company, Detroit, Mich., writes us as follows: "We wish we could suitably outline to you the talk which Mr. James Inglis, president of this company, made in an address to the employees assembled in our works, extending holiday greetings and expressing the satisfaction of the management at the continued very cordial relations which have existed between it and the men, and in which there has practically been no break during more than a quarter of a century. The old antagonism between the employer and the employee is gradually disappearing, and better relations are constantly being established. This is illustrated more forcibly at Christmas time than any other, it having become a pretty general custom for employers to remember their employees in some substantial way at that time. Two years ago this company distributed a large sum of money, by giving each one of their employees one dollar and one additional dollar for each year of continued employment. The largest single sum paid was $25.00, that being the entire life of the company at that time. Amounts ran from that to one dollar; no one received less than the latter amount. Last year, owing to the business depression, nothing of this nature was done, but this year the plan above outlined was again adopted."

HELP AND SITUATION AND FOR SALE ADVERTISEMENTS

No advertisements accepted unless cash accompanies the order.

Advertisements will be inserted under this heading at the rate of 4 cents (2 pence) per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent (½ penny) per word. But no advertisement will be inserted for less than 75 cents (3 shillings). Replies can be sent to our care if desired, and they will be forwarded without additional charge.

The National Motor Boat Show will be held at Madison Square Garden, New York City, Feb. 15 to 23, inclusive. This show will be under the auspices of the National Association of Engine and Boat Manufacturers, and is expected to be the largest and most successful yet held.

Blower Companies Consolidate.—The American Blower Company, Detroit, Mich., and the Sirocco Engineering Company, New York City, have been consolidated. The business will be carried on in future in the name of the American Blower Company, with the main office at Detroit, Mich. Mr. James Inglis will continue as president of the American Blower Company. Mr. William C. Redfield, who was president of the Sirocco Engineering Company, will be vice-president. Mr. Charles H. Gifford, the treasurer, was formerly general manager of the B. F. Sturtevant Company, and Mr. Still, the secretary, is chief engineer of the American Blower Company.

Removal Notice.—The Mianus Motor Works, Mianus, Conn., manufacturers of the famous Mianus marine gasoline motors, announce the removal of their Philadelphia, Pa., branch from 208 Chestnut street to the Exhibition Department, Philadelphia, Bourse building. This change was necessitated owing to their former quarters being inadequate to take care of their trade in Eastern Pennsylvania, Southern New Jersey and Delaware. A large line of motors and parts will be carried in stock in the Bourse, and the exhibit will be one of the leading attractions in the Machinery Department.

Vessels classed and rated in the *Record of American and Foreign Shipping* by the American Bureau of Shipping, 66 Beaver street, New York: American screw, *Mohawk;* American screw, *Cherokee;* American schooner, *Pharos;* American five-masted schooner, *Fuller Palmer;* American six-masted schooner, *Edward B. Winslow;* American schooner, *Stanley M. Seaman;* American schooner, *Holliswood;* American tern, *Rhoda Holmes;* American tern, *D. J. Sawyer;* American tern, *Charles A. Gilberg;* American barkentine, *Allanwilde;* American brig, *Newburgh,* and American brig, *Nanticoke.*

BUSINESS NOTES

GREAT BRITAIN

The Shields Engineering & Dry Dock Company, Ltd., North Shields, has sent us a list showing its output of engines during the year 1908. In this list are fifteen triple expansion and fourteen compound engines, with a total indicated horsepower of 9,795.

Isaac J. Abdele & Mitchell, Ltd., Brimscombe, during the past year built nineteen steel boats and launches, two wooden boats and nine sets of engines, totaling 700 indicated horsepower. This firm is now building five steam launches, three motor boats, four steel boats and five sets of engines.

MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.
314 Madison Avenue, New York City.

UNITED STATES NAVAL INSTITUTE.
Naval Academy, Annapolis, Md.

GREAT BRITAIN.

INSTITUTION OF NAVAL ARCHITECTS.
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.
207 Bath Street, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.
St. Nicholas Building, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

GERMANY.

SCHIFFBAUTECHNISCHE GESELLSCHAFT.
Technische Hochschule, Charlottenburg.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION

NATIONAL OFFICERS.

President—Wm. F. Yates, 21 State St., New York City.
First Vice-President—Charles S. Follett, 477 Arcade Annex, Seattle, Wash.
Second Vice-President—E. I. Jenkins, 3707 Clinton Ave., Cleveland, O.
Third Vice-President—Charles N. Vosburgh, 6323 Patton St., New Orleans, La.
Secretary—Albert L. Jones, 289 Champlain St., Detroit, Mich.
Treasurer—John Henry, 315 South Sixth St., Saginaw, Mich.

ADVISORY BOARD.

Chairman—Wm. Sheffer, 428 N. Carey St., Baltimore, Md.
Secretary—W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
Franklin J. Houghton, Port Richmond, L. I., N. Y.

Swan, Hunter & Wigham Richardson, Ltd., Wallsend and Walker-on-Tyne, launched during 1908 twelve steamships and five floating docks, the gross tonnage of which was 61,580.

Irvine's Shipbuilding & Dry Docks Company, Ltd., West Hartlepool, launched during the past year six steamships, with a total tonnage of 14,200.

Ropner & Sons, during the year 1908, launched two steel vessels fitted with triple expansion engines. The gross tonnage of these vessels was 5,005.

John Dickinson & Sons, Ltd., Sunderland, during the year 1908 built engines and boilers for six steamships, the total Lloyd's nominal horsepower being 2,040. In addition the firm built four extra boilers.

J. W. Brooke & Company, Ltd., Lowestoft, are now represented in the North of Ireland by the Belfast Marine Motor Company, Ltd., 28 Waring street, Belfast, and the company's Spanish agents at San Sebastian 2, Madrid, are the only agents for Brooke marine motors for the whole of Spain.

The annual convention and ball of the Institute of Marine Engineers was held in the King's Hall and Council Chamber, Holborn Restaurant, on Dec. 11. Immediately after the concert a reception was held by the president of the institute, James Denny, Esq., and Mrs. Denny.

J. Samuel White & Company, Ltd., East Cowes, Isle of Wight, during 1908 launched fourteen vessels with a gross tonnage of 2,555, and now have on hand seven unfinished vessels.

TRADE PUBLICATIONS.

AMERICA

"It's Up to You" is the title of a booklet issued by the Bridgeport Motor Company, Inc., Bridgeport, Conn. In these pages will be found some hints which the company has prepared for prospective purchasers who are not familiar with gasoline motors, the aim being to give such people an idea of how to make a proper selection. A free copy of this booklet will be sent to any reader who will mention International Marine Engineering.

"Her Last Hold" is lithographed in several colors on the calendar published by the Baldt Anchor Company, Chester, Pa. "I see a good ship riding all in the perilous road; the low reef roaring on her lee: the roll of ocean poured from stem to stern, sea after sea; the mainmast by the board; the bulwarks down; the rudder gone; the boats stove in at the chains; but courage still, brave mariners—the Baldt anchor yet remains."

"Valves and Fittings for Ammonia" is the title of catalogue 41 just published by Crane Company, Chicago, Ill. This is a cloth-bound volume of 128 pages, in which the statement is made that the valves and fittings therein illustrated (with the sole exception of malleable iron screwed fittings) are an entire new line, and were designed in accordance with the most approved engine practice as to standards, interchangeability of parts, proportions, thickness of metal, etc. No attempt was made to use old patterns and tools. A free copy will be sent to any of our readers who will mention International Marine Engineering.

Shipbuilders and shipowners should be interested in a booklet just mailed by the Polomeric Compound Company, Oakland, Cal. The manufacturer states that in offering Polomeric compound it is offering an article that has been tried and tested for the last year and a half by the Union Iron Works, of San Francisco. The claim is made that this is the only composition offered to the trade that has dissolved red lead putty; that it has no equivalent as a resistor of crude oil, and that it not only resists but hardens in the oil. When testing tanks on board ship, Polomeric is recommended as superior to any other compound, as small leaks can easily be stopped and a valuable cargo perhaps saved.

Ship and yacht owners, builders and naval architects should write A. B. Sands & Son Company, 20 Vesey Street, New York, for this company's handsome catalogue of marine plumbing and fixtures. A free copy will be sent to every one of our readers who will mention International Marine Engineering.

The Greenwald automatic engine, manufactured by the I. & E. Greenwald Company, Cincinnati, Ohio, is the subject of a 64-page catalogue published by that company. These engines are intended for use in electric light and power plants, for direct connection to electric generators, refrigerating machines, etc.

Features of "Graphite" for February.—Among the articles of interest in this issue is Chapter XI., on "The Preventing Corrosion of Steam Machinery," by W. H. Wakeman; "Castor Oil Lubrication" and "More Crucible Records." *Graphite* is published by the Joseph Dixon Crucible Company, Jersey City, N. J.

"The Ferro Special," a gas engine for launch, canoe, dinghy and stationary work where the load is constant, is described in illustrated bulletins published by the Ferro Machine & Foundry Company, Cleveland, Ohio. This is a special 3-horsepower motor, which is stated by the manufacturer to be strictly high-grade, with all modern improvements. The company states that it has been able to place a special low price on this machine by making 5,000 for the season's demand. Those interested should write for the "Ferro Special," mentioning this magazine.

"The Jones Stoker in Marine Service."—This is the title of two handsomely illustrated pamphlets published by the Under-Feed Stoker Company of America, Marquette building, Chicago. One of these pamphlets describes the installation of the Jones stoker on the lake steamship *James E. Davidson.* The other pamphlet consists of a description of this stoker on the hydraulic dredge *Francis T. Simmins.* Copies of letters are attached from G. A. Tomlinson, owner of the *James E. Davidson,* showing a very heavy saving in coal consumption, and from the president of the Commissioners of Lincoln Park, Chicago, owners of the *Francis T. Simmons,* also showing a great economy in coal consumption.

"Washington's Old Home at Mt. Vernon," a reproduction of the original painting by Henry P. Smith, is the subject of the 1909 art calendar published by the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio.

Metallic packing is described in an illustrated catalogue by C. Lee Cook Manufacturing Company, Louisville, Ky. This company makes a specialty of packing adapted to extra heavy duty service in both marine and stationary engines.

The "A B C" electric forge blower, made by the American Blower Company, Detroit, Mich., is, according to the manufacturer, "something to blow about." This blower is made in suitable size for blowing a single forge, and sells for $30. Blowers are also made for two and three fires.

Wilson & Silsby, sailmakers, Boston, Mass., have published a tide calendar, on which is a handsome half-tone picture, showing a race between the *Little Rhody II.* and the *Dorothy Q.* This is a very handsome picture, the cloud effects being especially noticeable.

"Eureka" packings, the Robertson-Thompson indicator, the Victor reducing wheel, and the Willis planimeter are among the steam specialties described and illustrated in circulars published by J. L. Robertson & Sons, 48 Warren street, New York City.

Steam turbines for direct-connected and belt service are made by the D'Olier Engineering Company, 119 South Eleventh street, Philadelphia. The company has just published leaflet No. 10, illustrating a number of different forms of its turbines.

The Racine Boat Manufacturing Company, Muskegon, Mich., has published an illustrated circular showing the plans of a 25-foot cabin cruiser, which it is prepared to build for $750. A full description is given of the construction of this boat and of the motor used.

TRADE PUBLICATIONS

GREAT BRITAIN

Extracts from notes on phosphor bronze by the Admiralty chemist. (Paper read at the meeting of the Institute of Metals, November, 1908.) "Specifications for phosphor bronze compositions which specify the amount of phosphorus to be present in terms of the amount of copper phosphide or tin phosphide employed in the mixture for melting, are regarded as unsatisfactory on account of their ambiguity. The only satisfactory method of specifying the amount of phosphorus is to specify the percentage which is to be present in the finished metal, thus allowing the manufacturer himself to proportion his additions of phosphorus in such a manner as to secure the final necessary percentage. Such additions must, of course, vary with the particular practice of melting, etc., adopted. For phosphor bronze bearings the amount of phosphorus undoubtedly should be high, but what the particular best limits should be, the writer is not prepared to state definitely. It should probably be from 0.8 to 1.0 percent, or possibly higher. From the results of the chemical and mechanical tests recorded in this paper, there appears to be some indication that in a given phosphor bronze alloy of definite composition containing from 88 to 90 percent of copper, the raising of the amount of phosphorus present tends to raise somewhat the ultimate tensile stress, but at the same time lower the percentage elongation of the material. The special characteristics of phosphor bronze are: 1. Its freedom from corrosion by salt water, which is apparently largely due to its freedom from zinc. 2. Its high qualities as a mechanical constructive material as compared with an ordinary zinc-free bronze. 3. The small effect which rise of temperature has upon its mechanical properties, which remain practically unimpaired at temperatures at which zinc containing copper alloys exhibit serious drops in strength. 4. A spark cannot be readily obtained from it by a blow. 5. Phosphor bronze of high contents possess low-friction coefficients for most metals, and are hard enough to resist abrasion well. On account of the above properties, phosphor bronze is particularly suited for boiler fittings and for fittings exposed to sea water, for the construction of machinery for manufacturing explosives, and for bearings for high-speed machinery. To ensure obtaining the best results, the manufacturers of 'Cog-Wheel Brand' phosphor bronze alloys, the Phosphor Bronze Company, Ltd., 87 Sumner street, Southwark, London, S. E., state that this brand should always be specified."

W. T. Ellmore & Son. Ltd., Thurmaston, near Leicester, are publishing illustrated leaflets describing their deck chairs.

Messrs. Dewrance & Company, 165 Great Dover street, S. E., have issued a neat catalogue of boiler and engine fittings. This catalogue is well printed and illustrated. Messrs. Dewrance's boiler and engine fittings are well known. This list deals with asbestos-packed water gages and cocks, stop, feed and isolating valves, lubrication pressure gages, unions, etc.

A circular has been issued by W. D. M'Kendrick & Company, Oakland Works, Motherwell, N. B., giving details of the "Oakfield" drill head. This is a new drill head for fixing to the columns of existing boiler shell drilling machines. It is said to be specially designed to take full advantage of high-speed cutting steel, and will drill holes up to 1 1/16 inches diameter at . . inches per minute rate of feed.

Power transmission is the subject of a catalogue issued in two sections by Rimington Bros., Carlisle. The two sections of this catalogue illustrate and describe almost every conceivable form of power transmission and accessories, such as shaft couplings of many kinds, roller bearings, shaft hangers, pulleys of all kinds, chain-driving devices, link steel belting, bucket elevators, machinery belting, etc.

Ball bearings and thrust washers are described in an illustrated catalogue published by Fisher's Ball & Bearing Company, Ltd., Hinckley street, Birmingham. The manufacturers state that these balls are technically perfect in construction and finish; that they are perfectly and equally hardened and almost indestructible; that they are remarkably long-lived, and that their cages are solid and robust and never break.

Magnolia anti-friction metal, made by the Magnolia Anti-friction Metal Company of Great Britain, Ltd., 49 Queen Victoria street, London, E. C., is the subject of an illustrated catalogue issued by that company. Several comparative tables of government tests are published in this catalogue, showing the results of the use of Magnolia metal and of white brass for steamship service.

Crosby indicators, for steam, gas or oil engines, pumps and compressors, hydraulic and ammonia plants, etc., are described and illustrated in a catalogue published by the Crosby Steam Gage & Valve Company, 147 Queen Victoria street, London, E. C. The catalogue states that many thousand Crosby indicators are fitted to marine and land engines; that they are supplied to the British and foreign governments, engineers, engine builders, steam users and technical institutes all over the world.

The "Gem" bench arbor straightener is described in circulars issued by S. Holmes & Company, Bradford. The circulars state that this machine has only to be installed in a shop to have its value at once appreciated. "The majority of turners, not being provided with such a machine, use the centers of the lathe for trueing purposes. This places a great strain upon the headstocks, and does great damage to the lathe. With this machine bent or crooked bars can be made straight with ease, and the work is done in a few seconds."

Michell patent thrust bearings for oil lubrication are described and illustrated in circulars published by G. B. Woodruff, 47 Victoria street, London, S. W. These bearings are designed with the object of securing in a collar bearing similar conditions to those which obtain in a journal bearing. In a collar bearing, it is said, the oil is squeezed out between two parallel surfaces, metallic contact taking place with correspondingly greater friction, and unless the pressure per square inch is kept very low the two surfaces seize. The statement is made that the Michell bearing will support a load of 500 pounds or more per square inch of rubbing surface, as against 60 or 70 pounds in the case of an ordinary collar bearing.

The patent adjustable, liftable flue covers, made by the Adjustable Cover & Boiler Block Company, Ltd., 64 Victoria street, Westminster, London, S. W., are described in an illustrated catalogue this company has published. Among the advantages claimed for this system are a great saving in fuel, because plants and flues can be swept clean of soot with ease and rapidity; no cracked brickwork, no chipping and no inrush of cold air into the flues, because this setting is said to fully allow for expansion and contraction; daylight for inspection secured and inspectors' work facilitated in every case; no dismantling of brickwork for inspection; interruptions of work during inspection reduced to a minimum. The catalogue states that a boiler can be laid bare for inspection and covered again in about one hour.

The Stern Sonneborn Oil Company, Ltd., Royal London House, Finsbury Square, E. C., has recently issued a small list dealing with "Sternol" lubricating specialties.

R. Waygood & Company, Falmouth Road, London, S. E., are publishing circulars regarding their lifts and cranes, in which the statement is made that they have fitted more than 100 lifts in steamships.

Iron and steel tubes and fittings of all kinds and sizes are the subject of illustrated circulars published by John Spencer, Ltd., Wednesbury, Staffordshire. This firm makes a specialty of boiler tubes and accessories, etc.

The Hornsby-Stockport gas engine and suction gas plant is decribed in illustrated pamphlets published by Richard Hornsby & Sons, Ltd., Grantham. It is stated that these gas engines are the product of thirty years of practical experience, and that more than 30,000 Hornsby-Stockport gas and oil engines have been sold.

Among the lists recently published by Willock, Reid & Company, Ltd., Glasgow and London, are those describing patent pressed steel split pulleys, new special air-hardening steel for high speed, standard file list, list of boiler tubes and of cast iron pipes, etc.

Messrs. J. H. Carruthers & Company, Ltd., Glasgow, issue an illustrated catalogue, in which are given sizes and other particulars of ballast and ash ejector pumps, air and circulating pumps, wet vacuum, feed, high and low service and other pumps, and also of condensers, feed-water filters, etc.

Messrs. Nalder Bros. & Thompson, Ltd., 34 Queen street, E. C., have published recently a catalogue of electrical instruments. The list is fully illustrated and priced, and deals with ammeters and voltmeters (direct reading, recording and portable), automatic switches and circuit breakers, wattmeters, etc., etc.

Brooke marine motors are described and illustrated in a handsome catalogue published by J. W. Brooke & Company, Ltd., Lowestoft. This firm states that most of their engines have been improved in details, besides which a 40-horsepower, six-cylinder motor and a special restricted hydroplane motor have been added. Moreover, considerable reduction in prices will be noted.

Bull's metal, for propellers, tail shafts, etc., are illustrated in a catalogue just published by Bull's Metal & Melloid Company, Ltd., Yoker, near Glasgow. Among the advantages claimed for Bull's propellers are increase of speed, permanent increase of efficiency, reduction in weight of the propeller and strains on the shaft, economy in repair account, and increase in strength.

BUSINESS NOTES

AMERICA

BLOWER COMPANIES' CONSOLIDATION.—Referring again to the announcement of the consolidation of the Sirocco Engineering Company, of New York City, and the American Blower Company, Detroit, Mich., the American Blower Company, under which name the consolidated companies will do business in future, writes us as follows: "The Sirocco fan is of English invention, and from the date of its introduction has entirely upset former fan theories and practice. In the United States the Sirocco met bitter competition from all blower manufacturers, but has steadily advanced, until it is now used in some of the most important installations in the country, in the navy, and for mine and general ventilation. A distinguishing feature of the Sirocco fan is the drum form of the runner, which consists of a large inlet chamber, enclosed by sixty-four long, narrow blades, curved forwardly. These blades take the place of the old paddle-wheel fan runner. How great an innovation the Sirocco fan proved to be is shown in the fact that for a given size of wheel at equal speeds, the Sirocco discharges four times as much air as former standard types of fans. For a given duty the Sirocco turbine wheel need be only about one-half the diameter of a paddle-wheel fan. It occupies only half the space, and saves one-third the weight and one-fifth the power of fans commonly in use up to the time of the introduction of the Sirocco. It is owing to these features that the merger of the Sirocco Company with the largest American blower concern is considered the most important step that has ever been taken in the history of the fan and blower business in the United States."

THE INDUSTRIAL INSTRUMENT COMPANY.—This company was organized by men who have long been engaged in the manufacture of measuring instruments, the leaders being B. B. Bristol, E. H. Bristol and W. E. Goodyear, all of Waterbury, Conn., who were for many years active in the development of the Bristol Company, and in the direction of its affairs during the time of its great development and success. The Messrs. Bristol, who were among the original incorporators of the Bristol Company, with several of their co-workers, withdrew from the company last spring, to develop a plan of larger scope and broader aims than was possible in that organization. Their plan involves the development of an extensive line of those types of measuring instruments and apparatus, the use of which promotes directly, or indirectly, safety and economy of operation in industrial plants, and oftentimes make possible operations which without such instruments or apparatus would be impossible. It is proposed to concentrate all energies in the development and sale of a harmonious line of apparatus for this one broad, economic field. This plan presents many advantages from the customer's standpoint, in that he is able to secure a certain distinct class of apparatus from one house, knowing that the component parts will harmonize and that he has obtained a well co-ordinated equipment designed to accomplish a certain result. He is relieved of the inconvenience of securing parts of an equipment from different makers, and of the responsibility and forethought necessary to insure their successful operation as a whole. From the vendor's standpoint it is, of course, an advantage to have a certain class of customers whose problems it is possible to study, so that their peculiar requirements may be met to a nicety. Lastly, manufacturers' efficiency is attained through the use of the same equipment for the production of several closely related articles rather than the employment of different equipment for each. The Industrial Instrument Company, which was formed to achieve the above purposes, is a Connecticut corporation, with authorized capital stock of $2,000,000. This company now owns the entire capital stock of the Standard Gauge Manufacturing Company, until recently of Syracuse, N. Y., and of the Standard Electric Time Company, of Waterbury, Conn. The Standard Gauge Manufacturing Company will be reincorporated in Connecticut. It has purchased a plant at Foxboro, Mass., into which it has moved from its outgrown quarters at Syracuse. The personnel of the organization includes instrument engineers of long experience, so that its engineering staff is capable of meeting successfully demands for apparatus of a special nature for particular conditions so long as it falls within the company's scope. This engineering will continually be engaged in the development of those types of instruments necessary to complete the line planned by it. The sales end of the business will be carried on by the Industrial Instrument Company, of New York, which has recently been formed for this purpose. This company will handle the entire output of the Standard Gauge Manufacturing Company, and also the industrial branch of the business of the Standard Electric Time Company. Its officers are: President, Bennett B. Bristol, formerly secretary and treasurer of the Bristol Company; vice-president, Walter W. Patrick, until recently manager of the New York office of the Bristol Company; secretary, Henry P. Dennis, formerly manager of Chicago office of the Bristol Company; treasurer, Arthur F. Mundy, secretary and general manager of the Standard Gauge Manufacturing Company. The home office will be located at Foxboro, Mass., with sales offices at 50 Church street, New York, and 753 Monadnock building, Chicago.

THE UNIQUE EQUIPMENT COMPANY, 59 Mill street, Astoria, N. Y., makes several specialties of interest to marine engineers, among them being the Unique metallic ring packing and the Unique turbine fan blower. The statement is made that "We guarantee to give a new engine of any description by using our new patented cylinder on our frame, and increase the efficiency of your plant with less cost and only a week's delay." The company rebores cylinders, valve parts and pumps in position.

WIRE ROPE FOR SHIP'S RIGGING.—The Durable Wire Rope Company, 26 Atlantic avenue, Boston, Mass., has received the following letter from Harold G. Foss, master of the schooner *Sallie C. Marvel:* "In reply to your inquiry regarding Durable wire rope with which my vessel is entirely fitted and rigged, beg to state that it has proved in every way satisfactory. The best recommendation of your wire rope that I know of is that our boom pennants are now seven years old (same age as the vessel), and, as far as I know, are just as good as new. Ordinary wire pennants last about three years. The standing rigging and the stays require very little care, and have always stood every test."

THE SHIPYARDS, DRYDOCK AND MACHINE SHOPS of the Frederick A. Verdon Company have passed into new hands. The old-established business of the Frederick A. Verdon Company, on the north shore of West New Brighton, Staten Island, has been purchased by Messrs. George H. Waters, David H. Gildersleeve and Frederic L. Colver, and the business will shortly be reincorporated under the name of Waters, Gildersleeve, Colver Company. In 1886, Mr. Verdon established his business as marine engineer and machinist in Jersey City, and six years ago removed to the north shore of Staten Island, there to obtain larger facilities for ship building and repairing, marine engineering and machinist work, as well as dry docking. Mr. Waters, who has been the superintendent of the Verdon business during the past six years, had a previous experience of nearly twenty years in the floating equipment department of the Pennsylvania Railroad, rising from an apprentice to the position of chief draftsman and assistant master mechanic. He is, therefore, a thoroughly practical man, and will continue as superintendent under the new company, of which he will also be president. Mr. Gildersleeve, who is a well-known mechanical engineer of ability, graduated from Stevens Institute in 1889. For nearly ten years Mr. Gildersleeve was active in gas engineering and in selling pumping and hydraulic machinery. He spent several years as first lieutenant in the United States Corps of Engineers in Cuba, during and following the Spanish-American war, and superintended the construction of the new sewerage system of the city of Havana. For the past five years he has been sales manager for the C. W. Hunt Company, manufacturers of coal-carrying machinery, and he comes to the Verdon business well equipped to hold the position as vice-president and sales manager of the company. Mr. Colver, who is the secretary and treasurer of the company, has been a successful magazine publisher for more than twenty-five years. For many years he was the president and active head of the Frank Leslie Publishing House, and later controlled the *American Magazine*, which magazine he sold in 1906 to acquire an active interest in the *Success Magazine*, and he was the founder, and for some time president, of the Periodical Publishers' Association of America. He will now give his entire time to the financial and business interests of the Waters, Gildersleeve, Colver Company. The Verdon shipyards have always done a good business, and in their present convenient location in the midst of New York harbor transportation, all sorts of harbor craft will find the new owners ready to meet their needs for construction and repairing and the supplying of all marine machinery.

A FREE BLOTTER.—The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, will, upon request, furnish any foreman boiler maker with one of its handsome celluloid blotters.

THE SOUTHERN BRANCH of the American Steam Gauge & Valve Manufacturing Company, of Boston, for several years located in the Equitable building, Atlanta, Ga., has removed its offices to the Candler building in the same city.

THE AMERICAN STEAM GAUGE & VALVE MANUFACTURING COMPANY, Boston, Mass., announces that Mr. John G. Guthrie has been appointed its sole representative in the Pittsburg district, with offices in the Columbia Bank building.

THE FIFTH ANNUAL REGATTA of the Palm Beach Power Boat Association, Lake Worth, Palm Beach, Fla., will take place on March 9 to 12, inclusive. Those interested should write for information to W. J. Morgan, Thoroughfare building, Broadway and Fifty-sixth and Fifty-seventh streets, New York.

MR. WILLIAM C. ENNIS, formerly superintendent of motive power and master mechanic of various railways, lately connected with the American Locomotive Company, and now located at 543 Broadway, Paterson, N. J., has been appointed the Falls Hollow Staybolt Company's Eastern traveling representative.

GOVERNMENT ORDERS for "Use-Em-Up" drill sockets, schedule of supplies No. 233 (hardware and tools), Bureau of Construction and Repair of the United States navy (Eastern yards), contained a request for bids on 12 dozen "Use-Em-Up" drill sockets, made by the American Specialty Company, Chicago, Ill. These sockets are similar to the standard taper socket with the exception of a flat on the inside, and are designed to use up taper-shank drills having the tangs twisted off or the shank broken. They are now in use by the United States government in twenty-seven different places, as well as in six places by the government of Canada and two places by the government of Mexico.

HELP AND SITUATION AND FOR SALE ADVERTISEMENTS

No advertisements accepted unless cash accompanies the order.

Advertisements will be inserted under this heading at the rate of 4 cents (2 pence) per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent (½ penny) per word. But no advertisement will be inserted for less than 75 cents (3 shillings). Replies can be sent to our care if desired, and they will be forwarded without additional charge.

BUSINESS NOTES

GREAT BRITAIN

The firm of Wailes, Dove & Company, Ltd., who exhibit at the Palace of Machinery, Stand No. 337, of the Franco-British Exhibition, their patent "Bitumastic" enamels, as applied to the ships of the British and foreign admiralties, the mercantile marine throughout the world, and to the plant of the chief industrial concerns, railways and municipal corporations in the United Kingdom, have been awarded two diplomas of the highest merit with gold medals, in classes referring to the mercantile marine and civil engineering, respectively. This firm also received gold medals at Genoa 1905, Milan 1906, Savona 1906, and Bordeaux 1907, for superiority of the anti-corrosive qualities of their patent "Bitumastic" enamels, covering and solution.

A large number of members of the Junior Institution of Engineers recently availed themselves of the invitation to visit Messrs. Siebe Gorman & Company's submarine engineering works, in Westminster Bridge Road, being received by Sir Richard Awdry, K. C. B., one of the directors; they listened to an extremely interesting address by Dr. Leonard Hill, F. R. C., on the physics and physiology of diving, caisson disease, etc. Demonstrations were carried out in the large experimental diving tank to illustrate the following: Diving apparatus as used in the British navy, fitted with telephone and electric lamps; self-contained diving apparatus employed in cases where the ordinary apparatus with pumps and air pipes would be impracticable; the Hall-Rees self-contained dress, enabling men to escape from disabled submarines. A glass-fronted air-tight chamber, filled with dense fumes, was brought into use for demonstrating the method of operating with the self-contained breathing apparatus in irrespirable atmospheres, for rescue work in mines, etc. Mr. H. A. Fleuss, the inventor of the first apparatus of this description, also spoke, giving an account of his experience in connection with the flooding of the Severn tunnel and other particulars of much interest.

A small but interesting twin screw steamer, constructed at the Neptune Works of Swan, Hunter & Wigham Richardson, Ltd., was launched on Jan. 21. This vessel, the *Simcoe,* was built to the order of the Canadian government, and is destined for use as a lighthouse tender and for buoy service in Georgian Bay. For these purposes the steamer is equipped with appliances for lifting exceptionally heavy weights, including powerful winches and derricks. The vessel is also adapted for safe navigation amongst the ice which she will frequently meet when on service. The steamer is being fitted by the builders with twin-screw triple-expansion engines, which receive steam from two watertube Babcock & Wilcox boilers. The vessel is 180 feet in length by 35 feet beam, built of steel, with poop and forecastle, the well between being adapted for the carriage of the larger buoys. The vessel is to be fitted with an installation for wireless telegraphy, and has a Stone's underwater ash expeller. The accommodation, which has been specially designed for comfort in both hot and cold weather, will accommodate not only the officials directly connected with the ship, but also the Canadian government officials whose duty it may be to inspect the lighthouses, etc. In addition to the ordinary equipment of boats, lifeboats, etc., a powerful steam launch is to be supplied.

MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.
314 Madison Avenue, New York City.

UNITED STATES NAVAL INSTITUTE.
Naval Academy, Annapolis, Md.

GREAT BRITAIN.

INSTITUTION OF NAVAL ARCHITECTS.
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.
207 Bath Street, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.
St. Nicholas Building, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

GERMANY.

SCHIFFBAUTECHNISCHE GESELLSCHAFT.
Technische Hochschule, Charlottenburg.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION

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Irvine's Shipbuilding & Dry Docks Company, Ltd., West Hartlepool, launched from their dockyard, on Dec. 24, the handsome steel screw steamer *Rouen,* built to the order of Furness, Withy & Company, Ltd., West Hartlepool. This vessel is one of the most up-to-date and one of the largest self-trimming colliers afloat, having extremely large hatchways and equipment for rapid loading and discharging, and is fitted with a complete installation of electric lights, having large clusters at each hatch. The dimensions of the vessel are as follows: 290 feet by 40 feet 2 inches by 20 feet 6½ inches. She is fitted with poop, bridge and topgallant forecastle. She is built to the highest class in British Corporation Registry. A cellular double bottom is fitted throughout, with extra large after-peak tank, thereby considerably immersing the propeller, and thus enabling the vessel to make passages in ballast condition without reducing her steaming qualities. The pumping arrangements have been so carried out that the whole of the water ballast can be pumped out in 2½ hours, which enables the vessel to make the port in a full ballast condition, while at the same time she is able to commence loading immediately. She is constructed with bulb angle frames and longitudinal stringers, and is sub-divided to give four clear holds. A powerful quick-warping steam windlass is fitted forward for working the cables, and steam steering gear is fitted amidships with hand-screw gear aft. Accommodation for the captain and officers is arranged in the poop; engineers in houses amidships; crew and firemen in the forecastle. The cabins throughout will be heated with steam, and the sanitary, ventilating and lighting arrangements have been effected on the most approved lines. Triple-expansion engines are being supplied and fitted by MacColl & Pollock, Sunderland, having cylinders 20½ inches, 33 inches, 54 inches by 36 inches stroke; two large single-ended boilers, 180 pounds pressure.

TRADE PUBLICATIONS.

AMERICA

Centrifugal pumps are the subject of an illustrated catalogue just published by the D'Olier Engineering Company, of Philadelphia, Pa.

Bulletins of Interest to Rope Buyers Sent Free.—"Plymouth Products" is the title of a series of interesting and handsomely illustrated booklets published by the Plymouth Cordage Company, North Plymouth, Mass. These bulletins take up the question of rope manufacturing from the raw material to the finished product, and begin with a few facts regarding the so-called manila hemp, which is not a hemp at all but a fiber obtained from the wild banana plant of the Philippine Islands. This plant has never been successfully cultivated elsewhere. A description is given of this plant and of the process by which the hemp is obtained. A full description is also given of the company's factory and various uses of rope which will be found of general interest to our readers. Any one who is interested will be placed on the Plymouth Cordage Company's free mailing list, to receive these bulletins regularly, by mentioning International Marine Engineering.

The Motor that Motes.—The Bridgeport Motor Company, Bridgeport, Conn., is mailing circulars "descriptive of the 'Special 1909 Bridgeport,' a new model which we have just brought out, and if you are still in the market for a motor this circular should interest you greatly. If you have gone into the motor question thoroughly, you are undoubtedly convinced as to the high standing of the Bridgeport motor, and that it is the most practical and economical motor which you can invest in. There are points of construction in our catalogue which cannot fail to impress you if you are in any way mechanical. These points are set out clearly, and the statements made by us are absolutely correct. We offer no misleading statements to assist in creating a sale, and if you place your order with us you are sure of receiving a first class, practical outfit. If there are any points of construction upon which you are not clear, kindly advise, and we shall be glad to give you detailed information. We are here to serve you in just such matters, and shall be pleased to receive your communications."

Oil filters are the subject of a circular which has been published by the Industrial Instrument Company, Foxboro, Mass. Among the new features claimed for the "Eclipse" filters are an automatic float-valve, regulating the flow through the filter. The company will instal one of these filters on trial for responsible parties.

"Oil vs. Coal" is the title of a pamphlet published by Tate, Jones & Company, Inc., Pittsburg, Pa. "There are several standard fuels—the most important of which are coal, gas and oil—all possessing their advantages and disadvantages. The oil, perhaps the least commonly known of any, possesses unquestionably the greatest value as regards the operating cost. There are a few isolated exceptions. The installation of oil fuel not only does away with the extra handling of the fuel (as the oil is conveyed to the respective furnaces through pipes), but leaves no residue or ashes to be removed afterwards. These advantages, coupled with those of uniformity of heat, perfect control over the fuel at all times, cleanliness, lower operating and maintenance costs, a material economy in storage space, safety against fires and other accidents due to flying sparks and hot coals, gas explosions, etc., and quickness with which a fire can be started, tend to prove the cause of the strong popularity of this class of fuel. These maximum results are, however, only possible where a thoroughly practical and scientific system or burner is employed, a burner which assures absolutely perfect atomization with a minimum air pressure. To accomplish these two important points a combination high and low-pressure oil burner, in which the oil is fed to the burner at from 15 to 25 pounds pressure, and there atomized by a small quantity of compressed air (or steam under certain conditions) at a slightly lower pressure is imperative, after which an air blast of from 2 to 6 ounces is used to supply the necessary amount of oxygen for completing combustion. This, briefly, is the principle upon which the Kirkwood combination high and low-pressure oil burner operates, and it has been found that the amount of compressed air required for atomization is so small that the supply required for a number of burners is almost negligible in a plant using compressed air for other purposes. In cases where it is necessary to install the suitable apparatus for operating the oil burner it will be found that the small amount of air consumed renders the cost of the plant a nominal one, while the operating expense will be very small."

1909 marine engines are described and illustrated in a catalogue issued by the Anderson Engine Company, Shelbyville, Ill. This catalogue states that the company has devoted many years to building these engines and bringing them up to their present high standing.

A valuable valve catalogue, which will be mailed free of cost to any of our readers upon request, has just been published by the Nelson Valve Company, Chestnut Hill, Philadelphia. This is a cloth-bound volume of 220 pages, showing gate, globe, angle and check valves in large varieties, made of various metals. Among the new features included are the new patented bronze swing check valves and hydraulically and electrically-operated gate valves. The listing of steel gate and globe valves for high pressures and superheated steam is said to mark a new era in high-class valve construction. Another innovation is the listing of open-hearth steel fittings. There are many engravings of both inside and outside views. The descriptive article and dimension lists immediately opposite the engravings facilitate easy and critical study of each of the valves. Test pressures as well as the working pressures are in each case given, so that the valve user has a definite basis for selection of the valve he wants.

Searchlights are the subject of a catalogue published by Carlisle & Finch Company, 229 East Clifton avenue, Cincinnati, Ohio. "To possess an electric searchlight has been the dream of almost every owner of a power boat, but how few have realized this dream is attested by the very few launches that carry anything but an oil lamp or an occasional acetylene light. To any one looking at the great number of launches and other small craft at any one of our numerous summer resorts, the fact will be most forcibly impressed upon him that few of them have any adequate means of illuminating their course at night. In fact, a great many do not carry any lights at all, thus jeopardizing the lives of those on board and proving an endless annoyance to steamers and other craft. We have made a careful and exhaustive study of this important question, and offer to the yachting fraternity a complete outfit of dynamo and searchlight, together with wire, switches, insulators, etc., ready to be put into position. Everything is furnished complete, so that the outfit may be shipped to the most remote localities and put on any boat without having to purchase any additional material. We are also furnishing electric light plants driven by gasoline engines which are complete and self-contained, and may be used on power boats, launches and sailing vessels for lighting incandescent lamps or a searchlight."

A small electric light and ignition outfit is made by the Richardson Engineering Company, 107 Liberty street, New York City. "We have designed the following outfits to meet the great demand for a real electric light plant for even the smallest launch. Although the quality of these goods is the best, the price is as low as is consistent with the best quality. These equipments have been made possible by our automatic storage battery charging box, which is a highly polished mahogany box resembling a spark coil box, having inside a voltmeter and an ammeter of the polarity type, our regular automatic storage battery charging switch and a control switch. On the face of the box are two openings covered with beveled glass, showing the scales of each meter, and on the side is a lever which operates the control switch. When this lever is pushed up the combination is arranged to connect the storage battery with the lights and to disconnect the generator from the storage battery. The voltmeter in this position indicates the voltage of the lights. This position is marked 'Discharge,' and the ammeter will register the amount of current used by the lamps, the pointer moving in a right-hand direction from zero. In the central position, marked on the box 'Off,' everything is disconnected, the voltmeter only indicating the voltage of the battery. Throwing the lever down to the position marked 'Charge' connects the generator with the storage battery through our automatic storage battery-charging switch, at the same time the lights are so connected that they can be used with perfect safety while charging the battery, and not burn any brighter than ordinary. If the engine is up to speed the automatic switch will make connection between the generator and the battery, the voltmeter will indicate the charging voltage and the ammeter pointer will move to the left, both indicating that the battery is being charged and at how many amperes. This box, 7 by 9 by 3 inches deep, contains all of the apparatus we have formerly used on our small switchboards. In a recess on the under side are the necessary terminals, the same as on a spark coil for connecting the various wires and also a plug fuse which protects the batteries both while charging and discharging. On the back of the box are printed directions for installing and operating."

The Fore River Shipbuilding Company, Quincy, Mass., has published a pamphlet devoted to its "capacity for miscellaneous work." This pamphlet describes the location of the company's shipyards, gives a partial list of the various naval and merchant vessels it has built, an account of its organization for productive work, and its capacity for making marine repairs.

The Richardson automatic sight feed oil pump is described in illustrated Bulletin No. 209, published by the Sight Feed Oil Pump Company, Milwaukee, Wis. This is a reissue of an older bulletin, but gives more information and in better ways.

Marine gasoline engines are described and illustrated in a catalogue published by Fairbanks, Morse & Company, Chicago, Ill. This catalogue states that the simplicity of the company's two-cycle engine, its ease of operation and reduced vibration, together with the steady motion due to an explosion at each revolution, makes it particularly desirable in small or high-speed boats.

"Aid to Shippers" is the title of a 72-page book containing a quantity of information of value to all engaged in the export or import trade. The book is issued by Oelrichs & Company, of New York, for more than forty years the American representatives of the North German Lloyd Steamship Company, who by reason of long experience are qualified to advise. The table of foreign moneys with United States equivalents, together with weights, measurements, tariffs, customs requirements, etc., etc., will be found of great value. *Aids to Shippers* will be sent, postpaid, on request to Oelrichs & Company, Forwarding Department, 5 Greenwich street, New York.

Grinding wheels and machinery and other Norton products, such as glass-cutting wheels, India oil stones, rubbing and sharpening stones, etc., are described in a handsomely printed and illustrated folder of 168 pages, just issued by Norton Company, Worcester, Mass. A complete description is given of the process of manufacturing alundum, which is "an electric furnace product—a remarkable reproduction of one of the minerals of nature, corundum, but of a quality far superior to the natural product." A free copy of this very valuable catalogue will be sent to any reader who will mention INTERNATIONAL MARINE ENGINEERING.

A handsomely printed and illustrated pamphlet, devoted to a description of the Quintard Iron Works, East Twelfth street, New York, has just been published. This concern was established in 1865, and since that time has carried on a general machinery and boiler business. It is equipped to handle all classes of work, both light and heavy. The forge department includes a hydraulic flanging machine and riveter, a large annealing furnace and a heavy steam hammer. Among the well-known boats which have been built by this company are the United States gunboats *Concord* and *Bennington*, the cruiser *Marblehead*, the Fall River Line steamer *Commonwealth*, J. Pierpont Morgan's yacht *Corsair*, the New England Navigation Company's steamships *Massachusetts*, *Bunker Hill* and *Old Colony*, and many others.

The thirty-third edition of the catalogue of Keuffel & Esser Company, which has just been published, is the largest as yet issued by this well-known firm, and will, no doubt, be of great interest to every engineer and architect. The general appearance of the catalogue has been much improved, and it is handsomely bound. Interspersed throughout the book are fine illustrations, showing for the first time the interiors of the general offices and factory buildings at Hoboken, N. J., which they now occupy, as well as glimpses of the stores in New York, Chicago, St. Louis, San Francisco and Montreal. An important change in the general arrangement of the catalogue has been made by creating a special section for "drafting-office furniture," which is now forming an important department among the goods manufactured. The catalogue contains 540 pages, and will be sent free of charge to readers who will mention this magazine.

"Fear Not to Sow" is the caption of a neat combined calendar and blotter issued by the Geo. H. Gibson Company, advertising engineers, Tribune building, New York City. They advise manufacturers of engineering supplies and equipment to prepare the way for large sales during the resumption of business by means of intelligently directed, educational publicity. They contend that advertising tends to reduce rather than increase the percentage expense of selling; that it reduces the risks of capital and the loss from idle capital; that it tends to expedite and simplify the work of both buyer and seller; that it leads to the education of the buyer as to the latest and most improved processes and methods; that it encourages intelligent and discriminating buying; that advertising is effective in proportion to its content of fact and argument; that it leads to the perfection of the product in order that the latter may have the strongest claims to the buyer's consideration; that it stimulates designing and producing to a high level of attainments, and, finally, that it accelerates engineering progress and makes engineering businesses more profitable. The growing indications of an approaching resumption of business in engineering lines, renders these matters of timely interest to manufacturers of engineering products.

TRADE PUBLICATIONS

GREAT BRITAIN

Tantalum lamps, made by Siemens Brothers' Dynamo Works, 6 Bath street, City Road, London, E. C., are described in an illustrated price list that firm has just published. This will be found of great interest to all users of electric lights.

Ball roller bearings are described in a catalogue published by the Auto Machinery Company, Ltd., Coventry. The statement is made that this company's twenty-three years' experience in the manufacture of steel balls enables it to offer absolutely perfect spheres.

Crosby indicators for steam, gas, or oil engines are described in two pamphlets published by the Crosby Steam Gage & Valve Company, 147 Queen Victoria street, E. C. These give prices, instructions for working, etc., and also deal with Amsler planimeters, speed counters, etc.

"Autogenous Welding for the Repair of Marine Boilers," by A. le Chatelier, chief engineer of the French navy, has been published in pamphlet form, and is distributed with the compliments of the British Autogenous Welding Company, Ltd., 268 South Lambert Road, London, S. W.

A booklet has been issued by Messrs. David Brown & Sons, Park Works, Lockwood, Huddersfield, dealing with cut gears of all kinds. Messrs. Brown make a specialty of this work, and in their new booklet they give spurs, bevels, worm-gears, double-helical gears, racks, etc., and also rawhide pinions.

Oil heating stoves are described in circulars distributed by the Valor Company, Ltd., Rocky Lane, Aston Corner, Birmingham. The advantages claimed for these stoves are that they are smokeless, easy to rewick, and have a patent indicator to prevent overfilling the container.

The advance price list of the Parsons Motor Company, Ltd., Town Quay, Southampton, for 1909, has just been published. A complete catalogue will soon be issued. Two entirely new sizes of motors have been introduced—the six-cylinder, 42-horsepower for launches, etc., and the two-cylinder, 30-horsepower for auxiliary work and low revolutions.

A well-illustrated catalogue of Messrs. Vaughan & Son, Ltd., Royal Iron Works, West Gorton, Manchester, dealing with overhead traveling cranes, has been issued. This pamphlet gives illustrations of the firm's well-equipped works, notes on speeds and powers for the different crane operations, together with motors, ropes, etc. Illustrations are given of multi-motor cranes of large size, and also for light loads. Hand-power cranes are also dealt with.

The Electric & Ordnance Accessories Company, Ltd., Cheston Road, Aston, Birmingham, has published a catalogue illustrating and describing its electrical and other apparatus, together with a trade discount sheet. This company states that one of the principal features of its gear is the entire absence of small parts. Its apparatus has been put forward and designed by experts, and the large number of repeat orders sent is evidence of the satisfaction given by the company's products.

D. W. F. patent ball bearings are described in an illustrated catalogue issued by Lud, Loewe & Company, Ltd., 30 Farringdon Road, London, E. C. The catalogue states that the very wide application of these ball bearings affords ample proof that they are satisfactory under all conditions prevalent in general engineering practice; that for years they have been running 12,000 to 14,000 revolutions per minute, and that this figure by no means represents the limit. The catalogue also mentions, as showing their suitability for heavy work, that they have been successfully employed for the bearing of fly-wheels weighing 15 tons. They are said to be especially suitable for propellers, shafts, conveyors, electric motors, dynamos, steam turbines, ventilators and the like.

Ward's metallic packing is described in an illustrated circular distributed by S. A. Ward & Company, Broad Street Lane, Sheffield. The manufacturer states that an ideal packing would be a perfectly broad and flat collar, fitting perfectly true to the piston rod bearing upon the face of a flat covering jointed on the end of a stuffing-box. "No ordinary pressure could pass it, but seeing that it is not practical the next approach to it is Ward's patent anti-friction metallic collar, divided and arranged in such a manner as to overcome the non-practicability of the ideal collar. This packing is largely used by British and foreign governments and in the mercantile marine of many countries.

BUSINESS NOTES

AMERICA

A noiseless and automatic stop check valve is made by the Schutte & Koerting Company, Thompson and Twelfth streets, Philadelphia, Pa "This valve, as the name implies, is used as a noiseless stop check or non-return on a battery of boilers, and supplies a very essential and vital part of the piping system. The desirability, or rather necessity, of a stop check valve on each boiler is now universally conceded by all engineers, the prime object being to prevent a back flow from main steampipe, should the pressure in any one boiler be lower. When pressures are equalized they will open and remain in that position without jumping or hammering. In case of accident to boiler through break of tube or joint, they will automatically cut off the boiler; also when fire under boiler is deficient or not properly attended to. Under this last condition the check answers the purpose of a tell-tale to point out a lazy boiler, and that its fire needs attention. The indication of this is a slight rattling sound at intervals, caused by the intermittent discharge from boiler to main steam line. By making this check valve a stop check valve, it answers at the same time as a stop valve, which every boiler must have, and by its use any boiler may readily be thrown out of commission. It also prevents steam being turned into cold boiler, should workmen be inside. These valves have a full measure of strength in all their parts sufficient to withstand not only the fluid pressure, but also weight and vibration of the piping of which it forms part. All parts are interchangeable and made to gage, so that new repair parts will fit in place. Our hard bronze composition gives excellent wear with superheated steam; but to make up for the loss of strength and superheat, we use air furnace iron for the body, at an advance of 15 percent on lists. The automatic noiseless stop-check valve has proven so satisfactory that many engineers will have but this one valve in the connection from each boiler to main line. Our preference, however, is an angle stop check valve on outlet from boiler, and a plain stop valve at inlet to steam line."

A. Eugene Michel, who has for the past three years been manager of the George H. Gibson Company, advertising engineers, has just opened new offices at 1572 Hudson Terminal buildings, New York. Mr. Michel will in future confine his efforts as an advertising engineer to the promotion of marine steam specialties, steam power plant apparatus, power transmission appliances and machine tools, and will limit his clientele to the number of firms to whose work he can give personal attention. Mr. Michel is a graduate engineer, associate member of the A. S. M. E., and with eleven years' advertising and engineering training, which includes practical experience in machine design, testing, etc., is well prepared to conduct the advertising of mechanical products. Among the accounts which Mr. Michel will handle are the following: Watson-Stillman Company, the Bird-Archer Company, the Diamond Chain & Manufacturing Company and James Beggs & Company.

The Nicholson Ship Log.—Barrett & Lawrence, Eastern agents for the Nicholson Ship Log, have just completed equipping the large auxiliary hermaphrodite brig *Columbine*, new name *Carola*, owned by Commodore Leonard Richards, of New York, with the No. 1 Nicholson Ship Log. It is interesting to note the large number of steam and motor yachts that are now being equipped with the Nicholson log. Several large auxiliary schooner yachts are also being equipped with the Nicholson log, both in New York and Boston. The names of these yachts are being withheld at the request of the owners, but it is evident that the yachtsmen realize the value of the Nicholson log, both as a navigating instrument and a means of knowing just what the vessel is doing. In case of an accident it is claimed that the chronographic record can be used as incontestable evidence in any court. One of the features of the Nicholson is that it can be located in the chart room, pilot house or on the bridge, where it can be seen at all times by the navigator or master. The instrument itself shows the time of day, indicates the speed of the vessel at the moment, counts the knots or distance run, and gives the readings within one-tenth of a knot. In addition to this it has a chronograph or recording attachment, which gives a complete and graphic record of the ship's speed performance for every twenty-four hours. For any further particulars write to Barrett & Lawrence, 662 Bullitt building, Philadelphia, Pa.

Removal of Oil and Grease from Boiler Feed Water.—Among the important problems with which marine engineers have to contend, and have always been attempting to solve, is that of completely removing the oil or grease from condensation water. The emulsion is caused by the churning of the mixture of condensed steam and lubricating oil in the engine or steam-pump cylinder. Attempts to remove the oil sufficiently to make a safe boiler water by means of separators have been partially successful. Coarser particles or drops of oil which have not been emulsified can be readily removed by either skimming or filtration. It will be found, however, that no matter how fine the filtering material has been, the milky appearance of the water caused by the oil has not appreciably changed, showing that considerable quantities of oil are still retained. As long as this cloudy appearance remains, the water will be unsafe for boiler feed, and will sooner or later be sure to cause serious trouble. It may also be mentioned that by the use of coagulants and chemicals, involving reactions of various kinds, the oil and milky appearance of such water may be removed, but any chemical treatment which necessarily leaves in solution many substances deleterious for boiler purposes cannot be recommended, owing chiefly to the well-known harmful effects of chemicals upon the valves, boiler plates and brass fittings. In seeking some suitable substance that would clear this condensation water completely, and without chemical treatment, with its attendant evils, Mr. Arthur E. Krause has discovered among the magnesian products of serpentine quarries a peculiar fibrous sand, which is practically insoluble, and by reason of its extraordinary physical property of attracting and retaining the oily matter in condensation water, is eminently fitted and suited to remove the last traces of oil. Its strong physical property of attracting greasy matter may be judged by the fact that the material will retain or absorb from 50 to 100 percent of its own weight of emulsified oil from the water after the coarser oil particles have been removed. That this method of purifying or freeing water from oil or grease is a purely physical and not a chemical one is shown by the fact that by suitable solvents the oil can be readily removed from the spent fibrous magnesian filtering material, and the oil so obtained may be used over again for lubricating, etc. The process, which is patented, and which is now being introduced, requires no more care than an ordinary sand filter, needs no expert attendance, and is continuous in operation, the only special requirements being a pressure pump of the requisite capacity. An additional advantage of this process is that by passing through the serpentine fiber, or material, the effects of the free sulphuric and other acids found in certain waters become neutralized, and the water rendered entirely safe and serviceable for boiler use. The apparatus for this process is manufactured by Alexander Miller & Bro., Jersey City, N. J.

The electric heat regulator made by the Geissinger Regulator Company, 203 Greenwich street, New York City, is claimed to be the only vibration-proof electric thermostat in existence. The manufacturer states that it will absolutely maintain accurate day and night temperatures in electric-heated staterooms, and that it saves from 40 to 50 percent of the current when compared with heaters not regulated. Records taken on board of modern Atlantic liners proving these statements are on file at the office of the company and will be submitted to anyone.

The Eureka Fire Hose Manufacturing Company, 13 Barclay street, New York City, writes us as follows: "Owing to the expansion of our business and necessity of carrying several months' supply of raw material on hand, we have begun the erection of a storehouse on Arlington avenue side of our plant. The storehouse will generally conform with approved plans of the Associated Mutual Fire Insurance Companies for brick and timber storehouses. The dimensions will be 74 feet 8 inches by 50 feet by 18 feet in the clear inside; the unusual height being to permit cases to be piled to good height, and allow room for traveling crane above. The walls will be 12 inches outside, pilasters 16 inches thick and 24 inches wide every 8 feet. Floor will be of concrete, and roof of plank and tar and slag, similar to roof of our rubber lining building. Girders 8 feet, centers 8 inches by 14 inches, supported by 8-inch by 10-inch posts, all yellow pine. Windows on both sides will be 2½-foot by 3-foot wired glass in stationary iron frames; front and rear will be ordinary sash. Construction of building will be precisely like our our other buildings, and strong enough to be carried up to four stories, as conditions warrant. The storehouse will be connected with our main building by means of concrete-covered walks, which will permit workmen and watchmen to pass to and fro under shelter, and also admit of conveyors to carry raw material into the different departments in the main building."

The seventh annual report of the Chicago Pneumatic Tool Company, Fisher building, Chicago, dated Dec. 31, 1908, shows, in spite of the business depression during the past year, a profit of $289,625. The net urplus of the company was $821,564.

The steel barge *Blackwood* has been delivered by the builders to the Lehigh Valley Railroad Company. This is the third barge of this type already delivered on an order for several, to be used in the coal trade between Perth Amboy and New York and other coast points.

Points in Regard to Applying Marine Glue to Seams of Decks.—Almost without exception, unsatisfactory results in using this material are occasioned by faulty application, and are produced entirely by two causes: First, either the oakum or cotton calking or the seams is damp when the glue is applied, and if there is any moisture in the seam, as soon as the sun shines on the deck the heat will turn this moisture into steam, which will force the glue up over the edge of the seam. Second, in paying the seam the ladle should be held at least an inch above the deck; if the ladle is drawn on or close to the seam a quantity of atmosphere will envelop, and has no time to escape before the glue becomes set. This will cause air bubbles, which in hot weather will also force the glue up over the edge of the seam, leaving it hollow and unsound. The seams must be absolutely dry and clean before the glue is run into them. If applied to old work the old material should be dug out perfectly clean. Whatever adheres to the sides of the seam should be removed with a rase knife. Full directions for the proper use of this material can be had by applying tc L. W. Ferdinand & Company, 201 South street, Boston, Mass.

BUSINESS NOTES

GREAT BRITAIN

The Cambridge Scientific Instrument Company, Ltd., Chesterton Road, Cambridge, has written us as follows: "From January the first of this year we have taken over the sole rights of sale and manufacture, outside the American continent and Germany, of the thermometers, gages, etc., of the Hohmann & Maurer Manufacturing Company, of London and Rochester, N. Y., United States America, and the regulators of the H. & M. Automatic Regulator Company, of Rochester. The instruments are largely used throughout Great Britain, the Colonies and the United States, and have earned a well-deserved reputation. With the information given us by the original company, together with the facilities we have for manufacture, we can ensure that the instruments will have their former high-class workmanship, and will be delivered quickly. Mr. Coppard, who represented the Hohmann & Maurer Company in the past, has entered our service. All communications with reference to these goods which were formerly sent to 98 Clerkenwell Road, London, E. C., should now be sent to us at the above address. With the knowledge obtained from our other pyrometric apparatus, we feel we are now in a position to advise clients on any temperature measurement problem likely to be met with in industrial practice."

MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.
314 Madison Avenue, New York City.

UNITED STATES NAVAL INSTITUTE.
Naval Academy, Annapolis, Md.

GREAT BRITAIN.

INSTITUTION OF NAVAL ARCHITECTS.
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.
207 Bath Street, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.
St. Nicholas Building, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

GERMANY.

SCHIFFBAUTECHNISCHE GESELLSCHAFT.
Technische Hochschule, Charlottenburg.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION

NATIONAL OFFICERS.

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The "Pioneer" patent oil separator for the separation of oil and lubricating grease from exhaust steam, is made by David Bridge & Company, Castleton Iron Works, Castleton, Manchester. This separator is stated to be perfectly automatic, to have no parts which can get out of order, to be extremely simple in design. It is said that it has for years been put to the most severe tests in connection with condensing and non-condensing engines. The firm supplies all the necessary piping, pumps, tanks, etc., includigg installing same by skilled men.

Messrs. Carr Bros., Ltd., 11 Queen Victoria street, London, E. C., have sent us the following communication: "The question of a good packing is one that interests all engineers of the present day. Rainbow packing has no equal on the market. It makes any kind of steam, air or hot-water joint, and lasts longer than any other packing in use. Rainbow will make a tight joint, however rough the surface to which it is applied. To ship builders, engine builders, etc., Rainbow is invaluable, as it obviates the necessity of facing joints, therefore reducing the cost of construction, as joints will remain tight much longer. Rainbow i not affected by contraction or expansion; it will hold the highest pressure, won't blow out, is not affected by any degree of steam heat, will not harden or crack, is not affected by oils, ammonia, liquids or alkalies. Joints can be made and broken in one-eighth the time consumed with packings that harden, as a tool is not required to break or face off joint. Thousands of joints in new plants can be made without the use of steam, with the assurance and guarantee that when steam is applied every joint will be perfectly tight. The manufacturer of Rainbow packing is the Peerless Rubber Manufacturing Company, of New York, and the European agents are Carr Bros., Ltd., London, of 11 Queen Victoria street, E. C."

TRADE PUBLICATIONS.

AMERICA

Thor air tools are the subject of a handsomely printed and illustrated catalogue of 30 pages published by the Independent Pneumatic Tool Company, First National Bank building, Chicago, a free copy of which will be sent to any reader who will mention this magazine. Among the pneumatic tools described in this catalogue are piston air drills, reversible and non-reversible; pneumatic reaming, tapping and flue-rolling machines; wood-boring machines; riveting, chipping, calking and beading hammers; hoists, motors, grinding machines, saws, flue expanders and pneumatic appliances of every description. Among the tools of special interest to shipbuilders illustrated are a No. 1 drill, drilling a wrought steel stern frame; the same tool reaming on the deck of a ship and also drilling on the side of a ship 50 feet above the ground; a No. 2 drill, drilling nickel-steel on ship work; a No. 25 reversible-piston air drill, compound gearing with slow speed, for extra heavy drilling, reaming, tapping, boring cylinders, rolling flues 4 inches in diameter, etc.

Fire hose and supplies are the subject of a profusely illustrated, cloth-bound catalogue of 224 pages just published by the Eureka Fire Hose Manufacturing Company, 13 Barclay street, New York City. This company was established in 1875, and has since been engaged exclusively in the manufacture of fire hose. Especial attention is called to the patented smooth interior construction used in the various brands of hose manufactured. An extra ply of fine, high-grade hose yarn is woven in the valleys of the inner surface, filling and making the interior of the fabric smooth and level, overcoming the ribbing or corrugating of high-grade rubber linings, said to be unavoidable in the old-style fabric, the effect of which was to produce corrugated surfaces, causing a great loss of pressure by friction. The statement is made that smooth interior ply makes a multiple-woven hose of a single hose, adding 25 percent additional strength to the jacket, and that this is a feature which can only be found in goods sold and manufactured by the Eureka Fire Hose Manufacturing Company. In addition to fire hose this company makes couplings, reducers, sprinklers, nozzles, release valves, gate valves, hook and ladder supplies, wire cutters, life belts and life nets, engine bells, alarm bells, helmets, etc., etc.

"Prism" is the title of a little magazine published by the Bausch & Lomb Optical Company, Rochester, N. Y., which should prove of interest to all amateur photographers. A free copy will be sent to any reader mentioning International Marine Engineering.

A valuable marine plumbing catalogue will be sent free upon request to any reader mentioning this magazine. A. B. Sands & Son Company, 22 Vesey street, New York City, have just issued Catalogue E, illustrating their complete line of plumbing fixtures, suitable for the smallest launch up to the largest yacht or steamship. This company has been in business sixty years and has been exclusively engaged in the manufacture of high-grade plumbing.

Heavy milling machines are described and illustrated in a catalogue published by the Niles-Bement-Pond Company, 111 Broadway, New York City. Owing to the great variety of sizes and combinations of horizontal milling machines built by this company, it is impossible to illustrate its full line, so that in bringing out this book the company is merely aiming to present the most common types and sizes used by the trade. These machines are built for different kinds of work; in some cases having but a single slabbing spindle, or combined with vertical or horizontal-facing spindles for operations of a special character. For locomotive connecting or side rod milling the heavier types of these machines are said to be particularly efficient. They are also used extensively for other kinds of heavy-duty steel work.

Bement hammers are the subject of a handsomely illustrated 52-page catalogue published by the Niles-Bement-Pond Company, 111 Broadway, New York City. A general description is given in this catalogue of single and double-frame hammers. These hammers take steam above and below the piston, and are all fitted with adjustable guides for taking up the wear of the ram. They are rated according to the actual weight of the falling parts, these parts consisting of piston, ram and ram die. For instance, an 1,100-pound steam hammer would have a piston, ram and ram die weighing 1,100 pounds. The rating takes no account of the top steam, which adds enormously to the blow. The actual force of the blow cannot be stated in pounds, for the reason that energy must be expressed in the foot pounds.

Metallic packing is described in an illustrated catalogue by C. Lee Cook Manufacturing Company, Louisville, Ky. This company makes a specialty of packing adapted to extra heavy duty service in both marine and stationary engines.

A handbook of information upon blowers and exhausters for forges and furnaces has been published by the American Blower Company, Detroit, Mich. The subject of this booklet is to enable a prospective purchaser to pick out the proper type and size of blower or exhaust fan for his requirements without the delay incident to correspondence, and to further the selling ability of the dealer who carries the A. B. C. lines in stock.

"The Ounce of Prevention" for rust formation is stated by F. L. Melville, 192 Front street, New York City, to be a preparation called Anti-Rust. Mr. Melville states, "I have had many years' experience in the manufacture of Anti-Rust. We know what it will do, but we don't ask you to take it on faith. If you will write us we will gladly send you a sample for testing in your own way."

An illustrated copy of the log for the season 1908 of the wrecking steamer *Favorite* has been issued in pamphlet form by the Great Lakes Towing Company, Rockefeller building, Cleveland, Ohio. This pamphlet is handsomely illustrated with full-page half-tones of the *Favorite,* her machinery, pumps, etc., and gives a full account of the many wrecking calls given her during the past year.

The value of electric heating for a great variety of industrial uses is shown by a booklet distributed by the Boston Last Company, Boston, Mass., illustrating and describing the Peerless electric heating and ironing outfits made by the Simplex Electric Heating Company, Cambridge, Mass., for use in the boot and shoe trade. The success of the simplex electric heating and cooking appliances has been fully shown by the large extent to which they have been adopted for use on board passenger vessels, steam yachts and for other such marine purposes.

"Safety Valve Capacity" is the title of a pamphlet issued by the Consolidated Safety Valve Company, 85 Liberty street, New York City. The pamphlet contains a paper on this subject, by Philip G. Darling, read before the American Society of Mechanical Engineers, Feb. 23, 1909. It was the purpose of this paper to show an apparatus and method employed to determine safety valve lifts, giving the results of tests made with this apparatus upon different valves; to analyze a few of the existing rules or statutes governing valve size, and to propose a rule giving the results of a series of direct-capacity tests upon which it is based; its application to special requirements, and, finally, to indicate its general bearing upon valve specifications.

Pneumatic tools are described and illustrated in folders published by the Cleveland Pneumatic Tool Company, Cleveland, Ohio. This company makes twenty-two styles and sizes of riveting hammers, equipped with either outside or inside throttle; eighteen styles and sizes of chipping, calking and beading hammers, also equipped with either inside or outside throttles. The company's four-piston air drill is made in all sizes, instantly reversible by twisting the throttle handle. The company also makes non-reversible piston drills. The statement is made that these drills contain one-third less parts than any other similar type of drills.

Patent packings for surface condenser tubes are the subject of a circular published by Joseph Allen, Box 14, Collingswood, N. J. "Something had to take the place of the old-fashioned lacing, and Joseph Allen's patent packings has solved the problem for the up-to-date man. With these packings, packing a surface condenser becomes a pastime. They can be inserted at the rate of eight per minute.. They are in use in every part of the civilized world. The United States navy, condenser builders, the largest power houses in the world, ship builders, steamships, waterworks, all use them. They last as long as the tubes. Send a ferrule and give depth of stuffing-box, and we will do the rest. Samples sent on request."

Fine mechanical tools are the subject of a very complete catalogue of 232 pages (No. 18 L) published by the L. S. Starrett Company, Athol, Mass., a free copy of which will be sent to any reader mentioning this magazine. Every tool made by this concern has the parts carefully tested at every stage of manufacture, and every completed tool is rigidly inspected before shipment, and is warranted accurate. Among the specialties of this company are steel rules of all kinds, steel measuring tapes, squares, calipers, micrometers, gages, steel clamps, hack saws, speed indicators, and, in fact, every kind of instrument of precision suitable for the naval architect, boiler maker, locomotive and engine builder and the like.

TRADE PUBLICATIONS

GREAT BRITAIN

The marine motors made by the Parsons Motor Company, Ltd., Southampton, are the subject of this company's 1909 motor list. The company states that its motors have the same general features of those made in past years, but that a number of improvements have been made in design and manufacture, and that a great increase in output enables them to be sold at lower prices.

A tube-cleaning appliance made by Charles Wicksteed & Company, Ltd., Stanford Road Works, Kittering, is described in circulars published by this firm. This device is said to be suitable for Babcock's and other water-tube boilers. It consists of a cleaning head driven through a flexible shaft of suitable length by an electric motor mounted on a truck and fitted with safety-reducing gear.

A handomely illustrated cloth-bound book of 156 pages has been published by William Denny & Bros. and Denny & Company, Dumbarton. A geographical and historical description of Dumbarton is given, accompanied by handsome colored lithographs and photographs of various members of the firm. Farther on are illustrations of the firm's works and many of the ships and engines built there.

Boats' davits, derricks and deck pillars, made of Mannesmann weldless steel tubes, manufactured by the British Mannesmann Tube Company, Ltd., Salisbury House, London Wall, London, E. C., are described in illustrated circulars which this company is distributing. Among the well-known firms which have placed orders with this company for the above-mentioned articles are: Barclay, Curle & Company, Ltd., Glasgow; Doxford & Sons, Ltd., William, Sunderland; Dobson & Company, William, Walker; Fairfield Shipbuilding & Engineering Company, Ltd., Govan; Fleming & Ferguson, Ltd., Paisley; Furness, Withy & Company, Ltd., West Hartlepool; Hamilton & Company, Ltd., William, Port Glasgow; Harland & Wolff, Ltd., Belfast; Irvine's Shipbuilding & Dry Docks Company, Ltd., West Hartlepool; McMillan & Son, Ltd., Archd., Dumbarton; Osbourne, Graham & Company, Hylton; Priestman & Company, John, Sunderland; Readhead & Sons, Ltd., John, South Shields; Ropner & Sons, Ltd., Stockton-on-Tees; Stephen & Sons, Ltd., Alex., Govan; Swan, Hunter & Wigham Richardson, Ltd., Wallsend and Newcastle; Thompson & Company, Robert, Newcastle; Thornycroft & Company, Ltd., John I., Southampton; Wood, Skinner & Company, Newcastle; White & Company, Ltd., John S., East Cowes, Isle of Wight; Workman, Clark & Company, Ltd., Belfast.

BUSINESS NOTES

AMERICA

Announcement is made by the Standard Roller Bearing Company, Philadelphia, of the further expansion of its sales organization by the appointment of F. M. Germane, formerly sales manager, as assistant general manager of the company; T. J. Heller as sales manager, and F. W. Lawrence as Western representative, the latter with headquarters at Chicago.

The former American Boiler Economy Company, of Philadelphia, manufacturers of the Copes Boiler Feed Regulator and the Copes Pump Governor, has been consolidated with the Northern Equipment Company, Old Colony building, Chicago, Ill., which will assume all obligations of the former company, including guarantees to replace free of cost any part of any Copes regulator that may develop a defect within five years from the date of purchase. The branch offices of the American Boiler Economy Company, Tribune building, New York City; Oliver building, Boston; 226 East Pleasant street, Baltimore, and the Frick building annex, Pittsburg, will be continued under the style of the Northern Equipment Company, while the sale of Copes regulators will be handled in Philadelphia by the Adjustable Grate Bar Company, North American building. The Northern Equipment Company announces that it will continue to install the Copes regulators on sixty days' free trial. The following recent sales to prominent concerns are mentioned: Nichols Copper Company, the Delaware & Hudson Railroad Company, the Clark Thread Company, the Consolidated Gas Company, of New York, and the Boston Elevated Railway Company.

THE IVES MANUFACTURING COMPANY, Baltimore, Md., is making a propeller wheel designed and built for speed, and the statement is made that this wheel, owing to its peculiar design and build, is not only a speed wheel but has been proved to be a powerful towing and pushing wheel, that the percentage of slippage is very low and the rate of speed high.

THE BILGE SYPHONS made by the Schutte & Koerting Company, Thompson and Twelfth streets, Philadelphia, Pa., are in use extensively on shipboard, and may be installed permanently for bilge clearing or used for emergency pumps in case of accident. They are made in sizes ranging in capacity from 200 to 2,000 gallons and upwards per hour. Further information may be obtained by writing for catalogue 2-A.

THE KOERTING OIL FIRING SYSTEM for marine and stationary boilers, made by the Schutte & Koerting Company, Thompson and Twelfth streets, Philadelphia, Pa., is said to be recognized as the cheapest and most efficient fuel. With this system neither steam nor compressed air is used. The oil is heated above the boiling or flash point at atmospheric pressure, and the moment the oil leaves the burner under the boiler it flashes into the finest atoms. This system will be installed on the new battleships *North Dakota, Delaware* and *Utah,* and on the torpedo-boat destroyers *McCall* and *Burrows.* For further particulars write for catalogue 6-O.

MR. D. D. PENDLETON, who was connected with the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., for some fifteen years, has recently opened an office as district sales manager of the American Boiler Economy Company, manufacturer of the Copes feed-water regulator and the Copes pump governor. This regulator so controls the inflow of water to steam boilers that the water level is held within narrow limits. The Copes regulator is said to be of especial value in steel plants and similar industries where sudden and irregular demands are frequently made upon the boilers. Mr. Pendleton's offices are located in the Frick building annex, Pittsburg, Pa.

MR. GEO. F. FENNO, for the last two years insurance engineer with the Middle States Inspection Bureau, an organization maintained by thirty-six of the leading fire insurance companies, has resigned in order to join the staff of the Geo. H. Gibson Company, advertising engineers, Tribune building, New York City. Mr. Fenno is a graduate of Sibley College, Cornell University, class of '06, and for some time after leaving school was telephone engineer for the New York & New Jersey Telephone Company. His experience with the Middle States Inspection Bureau has made him widely familiar with engineering and manufacturing plants, which will be valuable to him in his present work of promoting the sale of engineering supplies and equipment by means of publicity.

DULL TIMES NOT FELT AT THE ROBERTS BOILER WORKS.—The Roberts Safety Water Tube Boiler Company, Red Bank, N. J., write us that they have been running full force for a long time, and that they are far behind on their deliveries. This company recently shipped a 700-horsepower boiler to a concern in Boston to be installed in a high-speed steam yacht, and have also recently shipped the following boilers: One 5-foot by 7½-foot boiler for the United States revenue cutter *Penrose,* stationed at Pensacola, Fla.; one 5-foot by 7-foot boiler to a New York firm for export; one 2½-foot by 3½-foot boiler to a New York firm for export; one 3½-foot by 5-foot boiler for a concern in Pensacola, Fla.; one 3-foot by 4½-foot boiler for a company in Erie, Pa.; one 5-foot by 7-foot boiler to a New York house for export; one 5-foot by 7-foot boiler to an old customer in North Carolina for a tugboat. They are also now constructing the following boilers: One 7-foot by 10-foot boiler for a large firm in New York City; one 7-foot by 9-foot boiler for a steamship company in Portland, Me.; one 5½-foot by 9-foot and one 7-foot by 9-foot boiler for a large towing company in Maine, to be used on their towboats; one 3½-foot by 5-foot boiler, to be used on a high-speed launch, for a concern in Cambridge, Mass.; one 4½-foot by 6-foot boiler for an export house in New York City; one 6-foot by 5-foot boiler for a firm in New Haven, Conn., for use on their ferry line; one 3-foot by 4-foot boiler for a New York house for export; one 4½-foot by 6-foot boiler for an export house; one 3½-foot by 5-foot boiler for a Western firm. "A battery of large boilers for the United States ship *Cora,* stationed at Providence, R. I., and which belongs to the Engineers Corps, United States army, the first bids for which were thrown out and new specifications issued, the competition being very keen. The Roberts Company was not only the lowest bidder in the first instance, but also when the second bids were opened, and the contract accordingly was awarded to them."

C. F. Petersen, known as a designer and manufacturer of portlights, has opened a place of business at 29 South Seventh street, Philadelphia, Pa. He will be pleased to send to anybody interested his price list of the different kinds of portlights he manufactures.

Schuchardt & Schutte, manufacturers, exporters and importers of machinery, small tools, hardware and steel, have moved their New York offices and warerooms from 136 Liberty street to 90 West street.

The Rockwell Furnace Company, 26 Cortlandt street, New York, has purchased the factory, drawings, patents, etc., of the Rockwell Engineering Company, and the combined business will hereafter be transacted under the name of the Rockwell Furnace Company.

The American Manganese Bronze Company, New York City, has moved its main office to its works at Holmesburg, Philadelphia, Pa. The company still retains its sales office at 99 John street, New York City, it being the intention of the treasurer, Mr. W. A. Locke, to be in New York on Thursday of each week.

The State Steam Engineering School, conducted by Jas. Coyne, M. E., 121 Haverhill street, Boston, is described in an illustrated pamphlet Mr. Coyne is distributing. This school was established twelve years ago for the purpose of assisting engineers and firemen to comply with the requirements of the license law.

E. H. Stevens, formerly general superintendent of plants of the Public Service Corporation of New Jersey, has resigned that position to become vice-president and general manager of the Bird-Archer Company, manufacturers of Bird-Archer boiler compounds, 90 West street, New York City. During his fifteen years' experience in power plant operation costs and management, Mr. Stevens has had complete charge of plants aggregating several hundred thousand horsepower, and is therefore especially well prepared to deal with questions about feed-water heating. Mr. Stevens will have complete charge of sales and will give his personal attention to inquiries from large plants which have hitherto shown serious economical loss and high operating costs on account of scale, oil deposits and other troubles caused by bad feed water.

The Eureka Fire Hose Manufacturing Company, 13 Barclay street, New York City, has received contracts from Buffalo for 5,000 feet of 2½-inch hose and 1,000 feet of 3½-inch hose; from Jersey City for 1,950 feet of 2½-inch hose; all four-ply, manufactured for high-pressure pipe-line service under the new improvements.

Mr. Harry Vissering, who for the last ten years has been general sales agent of the United States Metallic Packing Company, with offices in Chicago, has resigned, and has also resigned his position as superintendent of the American Locomotive Sander Company.

On March 27, many friends, including employees, guests and corporation members, gathered at the works of the Plymouth Cordage Company, Plymouth, Mass., to do honor to Mr. G. F. Holmes, its treasurer and general manager, upon the occasion of the fiftieth anniversary of his entering its service. Fifty years ago the annual output was only 3,750,000 pounds, and 118 hands were employed; in 1882, when he became treasurer, the annual output amounted to 12,000,000 pounds, and 303 hands were employed on the payroll. Now the yearly business is 90,700,000 pounds, there are 1,625 employees, the annual payroll is $765,000, and the business covers all parts of North America, extends as far East as Turkey, and covers many ports of South America and Africa. Mr. Holmes, to whom in the greatest degree the remarkable increase is due, is to-day said to be the foremost man in the industry as well ast he head of the foremost concern in that industry.

BUSINESS NOTES

GREAT BRITAIN

Joseph Allen, inventor and manufacturer of patent packings for surface condensers, Collingswood, N. J., announces for the benefit of his English customers that he is represented by Messrs. Taylor & Son, 56 Wapping, Liverpool, as agents for Great Britain. This firm carries stocks of all sizes. Other foreign agencies will be announced later.

Messrs. Siemens Brothers' Dynamo Works, Ltd., inform us that on April 2 their incandescent lamp and fittings department was removed to much larger premises at Tyssen street, Dalston, N., in order to cope more effectively with their increasing business. All communications referring to the above matters previously addressed to 6 Bath street, City Road, E. C., should after that date be sent to their new address at Dalston.

A New Auxiliary Motor Outfit for Yachts.—Yacht owners have long felt the need of some simple device to enable them to be independent of calms, but hitherto the necessity of making extensive structural alterations to the hull has prohibited, in the majority of cases, the installation of the recognized type of auxiliary motor. To overcome this difficulty the Ailsa Craig Motor Company, Chiswick, London, is now supplying a patent device which can be easily and quickly installed on practically any type of sailing yacht and requires no alteration whatever to the hull. Moreover, the whole outfit can be fitted while afloat, and can be easily removed altogether and stowed on shore should a vessel wish to race. The device is simplicity itself, and consists of a spar, which is slung over the side of the vessel, and along which runs a length of shafting. At the lower and after end of the shaft, which lies under the counter of the vessel in clear water, is the propeller, and at the upper and forward end, which bears against a suitably arranged thrust chock, is a pulley. A belt connects this pulley to the motor, which is bolted to the deck, usually just abaft the mast. It would be thought that the spar would tend to swing away from the vessel, but as a matter of fact the action of the propeller keeps it bearing so hard against a distance piece slung over the side of the vessel that it is almost impossible to push it away. The steering under way is perfect; in fact, far less helm is required than is needed when running before the wind. Now, it should be clearly understood that the apparatus is not intended for the man who wants a motor yacht. It has been designed solely for that very large class of yachtsmen who require a small auxiliary power to enable them to reach port in a calm, or to save a tide, without impairing the sailing qualities of their ships in any way. For this purpose it is ideal, as the room taken up is quite negligible, and it is no more trouble to handle the propeller spar than a spinnaker boom. It can be easily got out in three minutes.

The automatic waste oil filter made by the Valor Company, Ltd., Rocky Lane, Aston Cross, Birmingham, is stated by the manufacturer to be the best and most effective filter on the market, and that it thoroughly cleanses dirty oil so that it can be reused, thus effecting an enormous saving in oil bills.

An Efficient Piston Ring.—The Standard Piston Ring & Engineering Company, Ltd., Premier Works, Don Road, Sheffield, states that the springs of its piston ring combine the necessary vertical and lateral actions in better proportion to their needs than any ring which has yet been put before engineers. Especially attention is called to the large amount of bearing surface on the springs acting on the piston ring flanges. These springs produce a maximum amount of vertical pressure against the piston flanges—just where it is wanted—enabling the rings to be worked at the very highest pressures and speeds. They may be adjusted to a nicety, and the manufacturers state that they may be relied upon to keep the ring steam-tight with the minimum amount of friction on the cylinder walls; also that their action is simplicity itself, as there is nothing to get out of order, and that they will last an indefinite period.

Launch of the Steamship *Magdalena*.—On March 8, Messrs. Craig, Taylor & Company, Ltd., launched from their Thornaby shipbuilding yard, Thornaby-on-Tees, a handsomely modeled single-deck screw steamer of the following dimensions: 298 feet by 44 feet by 21 feet 1 inch molded. She is built of steel, to the highest class in Lloyd's, under special survey, and has poop, bridge and topgallant forecastle; water ballast in double bottom fore and aft and in peaks. She is equipped with patent steam windlass with quick warping ends, steam steering gear, five steam winches and suitable donkey boiler, pole masts and all the latest improvements for rapid loading and discharging. The accommodation for captain and officers is neatly fitted up in deckhouses amidships, the engineers being in deckhouse alongside engine casing, and the crew in the poop. Her engines have been constructed by the North Eastern Marine Engineering Company, Ltd., Sunderland, the cylinders being 21, 35, 57 by 39, with two large steel boilers working at 160 pounds pressure. The vessel has been built to the order of A. C. Lensen, Esq., of Terneuzen, under the superintendence of W. C. Carter, Esq., of London.

TRADE PUBLICATIONS.

AMERICA

Catalogues are wanted by the Puget Sound Iron & Steel Works, Tacoma, Wash., as this concern is erecting a new plant for the manufacture of hoisting and logging engines as well as for marine engines and the repair of engines and machinery of all kinds. Catalogues are also wanted of all sorts of supplies for machine shops, foundry, forge and pattern shops.

"Vanadium Steels" is published by the American Vanadium Company, Frick building, Pittsburg, Pa. The subject of this book is the classification and heat treatment of vanadium steels, with directions for the application of vanadium to iron and steel. Vanadium steel is said to be especially suitable for anchors, condenser tubes, crank pins, crank shafts, cylinders, cylinder heads, deck plates, feed-water heater tubes, marine engine forgings and pins, boiler plates, boiler tubes, rivets, ship plates, etc.

A machinery and tool catalogue will be sent free to any reader mentioning this magazine, by the Brown & Sharpe Manufacturing Company, Providence, R. I. This is a very complete volume of nearly 600 pages, listing milling, grinding, automatic gear-cutting machines, screw machines, cutters, accurate test tools and machine tools of all kinds. There is a very complete index, which will prove of great value to all who consult the catalogue. In the back of the catalogue are a large number of valuable tables of wire-gage standards, weights, etc.

A price list of port lights, ship's lights and deck lights has been issued by the C. F. Petersen Company, 29 South Seventh street, Philadelphia, Pa. Among the advantages claimed are simplicity of construction, neatness of appearance, watertightness and interchangeability of parts. The metal used is high-grade yellow brass; the rubber is of the best kind, and the glass is a heavy plate and with ground edges. Great care has been taken to make all parts strong and durable, and the manufacturer has been equally careful to avoid any unnecessary weight, in order to reduce the material cost and to save every ounce that can be saved to advantage. The company makes a large number of styles, in addition to those illustrated in the price list, to suit special conditions and requirements.

A list of highly-pleased users and jobbers of portable-hand metal punch has been sent us by the manufacturer of these punches, the W. A. Whitney Manufacturing Company, Rockford, Ill. These metal punches weigh but 11 pounds, and are 23 inches in length over all. Their capacity is from 1/8 to 1/2 inch, and they are in use in a large number of United States navy yards and arsenals.

Submarine Signal Bulletin No. 32 has just been issued by the Submarine Signal Company, 88 Broad street, Boston, Mass. This bulletin gives a large number of reports of the distances from which this company's signals have been heard by a large number of well-known trans-Atlantic liners and coasting vessels. A fair sample is the report from the captain of the *Kaiser Wilhelm der Grosse*, who states that he heard the Fire Island light vessel at a distance of 14 miles in the fog; made the lightship by the bell alone, and passed close by, the fog-horn not being audible at a distance greater than 3 miles.

Dredges and dredging machinery are described in a handsomely illustrated cloth-bound catalogue published by the Bucyrus Company, South Milwaukee, Wis. Among the dredges described in the catalogue are the 10-yard dipper dredge *Old Hickory,* owned by the Duluth-Superior Dredging Company, which is the largest dipper dredge ever built, and placer dredge *No. 155,* owned by the Folsom Development Company, which has a record of 250,000 cubic yards in a single month. A free copy of this catalogue will be sent to any of our readers who will mention INTERNATIONAL MARINE ENGINEERING.

The "Johansson" combination standard gage is illustrated and described in a catalogue published by Grönkvist Drill Chuck Company, 18 Morris street, Jersey City, N. J. The manufacturers of these gages state that the ideal standard gage is one which at first glance would appear to be an anomaly; that is, a solid adjustable gage; one which can be set to size as readily and accurately by a heavy-handed laborer as it can be by a tool maker or a master mechanic, and which within wide limits is for all sizes infinitely adjustable; a gage which does not depend upon separate measuring means for its accuracy, and one in which the measuring members are self-checking. According to the Grönkvist Drill Chuck Company, the "Johansson" gages are the only ones made which fulfill all of these requirements.

A sample copy of the *Penberthy Engineer and Fireman*, a monthly magazine of 80 pages, will be sent free to any of our readers who will mention this magazine. The subscription price is 50 cents a year, including a handsome watch fob premium. The claim is made that this magazine has over 3,500 paid subscribers. It contains a great deal of matter of interest to all engineers and firemen.

Economizers in the power plants of steel mills and machinery manufacturers is the subject of Bulletin No. 163 issued by the B. F. Sturtevant Company, Hyde Park, Mass. The installations described and illustrated in this bulletin are those in the plants of the American Steel & Iron Company, the Cleveland Cliffs Iron Company, the Bethlehem Steel Company and the B. F. Sturtevant Company.

"Drills and Sockets that are Different" is the title of a pamphlet just issued by the American Specialty Company, Chicago, Ill. This booklet is devoted to describing the Collis high-speed drill, which combines two principles—a rolled section high-speed steel blade and a standard taper shank. This combination produces, according to the manufacturer, a drill having the accuracy of a high-grade, high-priced, high-speed milled drill, and the toughness, strength and cutting qualities of a flat twisted drill. Having a common standard taper shank, no special chucks are required. These drills are made in both the flat and in the flat-twisted types.

Gasoline machinery for vessels, for hoisting sails, pumping water, operating windlasses and hoisting cargo, is the subject of an illustrated booklet which is issued by the Mianus Motor Works, Cos Cob, Conn. The statement is made that in order to supply a cheap and reliable power that may be used with all sailing vessels, large or small, the company has designed its present line of gasoline outfits, which have been made for the past five years, and which the Mianus Motor Works states have given such universal satisfaction, and have so demonstrated their superiority over steam that many new vessels now building are installing the company's gasoline power.

The Koerting multi-jet eductor condenser, without air pump, is described in illustrated catalogue 5, issued by the Schutte & Koerting Company, Twelfth and Tompson streets, Philadelphia, Pa. Makers of condensing plants have in their ordinary practice during recent years been obliged to meet the demands for higher vacuum than was formerly the case. For many years the Schuette & Koerting Company has made eductor condensers for vacuum up to 26 inches, but for large units and, accordingly, high steam consumption, and for high vacuum where the amount of water runs into high figures, the company states that it has succeeded in meeting all requirements by developing a multi-jet eductor or condenser which has a much smaller water consumption, while maintaining the essential qualities of the company's single-jet Koerting eductor condenser; that is, no air pumps, no moving parts, and simplicity of operation.

The Motsinger duplex rotary engine is described in an illustrated circular published by the Motsinger Rotary Engine Company, Greensburg, Pa., a free copy of which will be sent to any reader mentioning this magazine. This catalogue states: "There are three main types of steam engines: the reciprocating, the turbine and the rotary piston engines. By far the greatest perfection for all uses, up to the present time, has been the reciprocating type, with its reversibility, close-fitting pistons and valves and great economy when compounded. In recent years the Parsons and Curtis turbines have found an acceptable field in large power plants and in fast-speed marine service; but their great cost, non-reversibility and lack of power and economy, except as condensing engines, run at very high speeds, make their general adaptability limited, and their continued use in their present field doubtful. The single rotary piston engine has, from the invention of the first steam engine, been the ideal of most inventors and mechanical engineers. The great Watt himself tried hard to make a successful rotary piston engine and failed. Perhaps more money has been spent in research work on this type of engine than on all other types combined. Even since they have been building Parsons turbines the great Westinghouse Company have spent much money to secure a successful rotary piston engine, and have not reported success. Yet with great respect for the reciprocating engine, which has done so much for humanity and for the turbine, which also promises much, the inventor of our engine, after years of study of known defective conditions, has solved this fascinating problem by the completion of the Motsinger double rotary engine, which not only eliminates all the bad features of both reciprocating and turbine engines, but retains all their good points. And, like all great scientific discoveries, it is simple in construction, and costs less to manufacture than either the reciprocating or turbine types, and will prove the longest lived under hard service."

A sheet packing, which is stated by the manufacturer, the H. W. Johns-Manville Company, 100 William street, New York City, to be the ideal packing for superheated steam and high pressure is "J-M Permanite Sheet Packing." The claim is made that this packing is a successful attempt to combine all the good features of asbestos and rubber into one packing, and that this packing is so constructed that it has nearly the same pliability as rubber-sheet packing, thus making it adjustable to any joint.

Coal and ore-handling machinery is described in illustrated catalogue O-91, published by the C. W. Hunt Company, West New Brighton, N. Y. This is a volume of 88 pages, and will be found of great interest to all users of such machinery, whether for shipping docks, boiler rooms, coaling stations or other purposes.

The April issue of *Graphite,* published by the Joseph Dixon Crucible Company, Jersey City, N. J., is largely devoted to the subject of lubrication. The principal article is "The Milling Point of Lubricating Compound," dealing with important considerations in connection with greases, and giving the temperature at which Dixon's graphite greases melt. Any of our readers wishing to be placed upon the free mailing list of *Graphite,* published monthly, will receive the magazine regularly by writing to the company and mentioning this magazine.

"The Cruise of the Atlantic Fleet" is the title of a handsomely illustrated booklet published by the Baldt Anchor Company, Chester, Pa., a free copy of which will be sent to any reader who will mention International Marine Engineering. This booklet shows half-tone photographs of the various ships of the fleet and of their progress through the Straits of Magellan and other locations, besides giving a map of the route around the world, photographs of Admiral Evans, President Roosevelt and others, and a brief description of "the first war fleet to circle the globe." The fleet was equipped with Baldt anchors.

A pocket edition general catalogue has just been got out by the Joseph Dixon Crucible Company, Jersey City, N. J. This lists the company's principal products, such as crucibles, facings, lubricating graphite, greases, pencils, protective paint, etc., giving brief descriptions and prices. It is of value to the purchasing agent, engineer, contractor, superintendent, and any one, in fact, who uses or specifies graphite in any form. The booklet is of commercial envelope size, and will conveniently go in the pocket or desk pigeonhole. It is substantially bound in tough cover stock, and attractively printed. If you want a copy address the Joseph Dixon Crucible Company, at the home office, and mention this publication.

TRADE PUBLICATIONS

GREAT BRITAIN

Cane furniture, especially designed for use on board ship, is illustrated in a catalogue issued by W. T. Ellmore & Son, Ltd., Thurmaston, near Leicester.

Messrs. Vosper & Company, Ltd., Broad street, Portsmouth, have recently issued a catalogue of engines and boilers for yachts and launches. The list deals with engines of the vertical marine type, ranging in size from triple-expansion sets with cylinders 12½ inches, 19 inches and 31 inches in diameter by 21-inch stroke to single-cylinder engines, with cylinders 3¾ inches in diameter and 5-inch stroke. Details are also given of vertical boilers and Yarrow-type boilers of suitable sizes for the smaller sets.

Messrs. Babcock & Wilcox, Ltd., Farringdon street, London, E. C., have issued a splendidly got-up catalogue, giving a list and description of the various vessels fitted with their well-known forged steel watertube marine boilers. This catalogue, which extends to nearly 200 pages, contains a very large number of full-page illustrations showing the different types of vessels fitted with the boilers. The book is beautifully arranged, excellently printed and illustrated, and bound in a style in keeping with the importance of the catalogue.

Messrs. Siemens Brothers' Dynamo Works, Ltd., Tyssen street, Dalston, N. E., announce that they are now able to supply "Tantalum" lamps for 200-250 volts, in 32 and 50 candle-power. In general appearance these lamps closely resemble "Tantalum" lamps of lower voltage, except that they contain two filaments wound upon two sets of supporting arms instead of one only. They possess all the advantages, such as mechanical strength, long life and suitability for burning at any angle, which have been the distinguishing qualities of "Tantalum" lamps hitherto. We have received a circular containing particulars of the new lamps, together with details concerning "Tantalum" candle lamps. The latter are supplied with plain candle-shaped bulbs, for use in candle fittings with small bayonet or small Edison screw caps for 24-40 volts, 5 or 10 candle-power. This circular, which is of the same size as their catalogue 4a, will be supplied to any address on receipt of inquiry.

Messrs. D. Ramsay Smith & Company, Cheyene Walk Works, Chelsea, London, have issued a pamphlet dealing with special forms of screw propellers for towing and for high-speed and shallow-draft boats of small tonnage.

An attractively got-up catalogue has recently been issued by Messrs. Stewarts & Lloyds, Ltd., Birmingham, Glasgow and London. It gives details of their wrought iron and steel pipes, and tubes and fittings of all kinds. The list contains tables of weights, etc., and also deals with valves and cocks, boiler-tube tools, pipe fitters, stocks and dies, steel castings and other products of this well-known firm.

"Dodo" enamel, which is stated to be especially suitable for ships and yachts, is the subject of an illustrated catalogue just published by Duggan, Neel & McColm, Ltd., Langbourne Wharf, Millwall, London, E. C. This enamel has been made with the special aim of withstanding the action of sea air and salt water. The manufacturer states that it will not blister, and being extremely elastic it will not crack, even in the most exposed work.

We have received from Messrs. Siemens Bros. Dynamo Works, Ltd., Tyssen street, Dalston, N. E., a new catalogue dealing with "Tantalum" lamps and fittings specially designed for ship lighting. In general arrangement it is original, and contains a good selection of cheap and handsome fittings. The list also deals with metal and carbon filament lamps of convenient voltage and candle-power, and in its entirety is a very useful publication to all interested in ship-lighting installations. We are informed that a copy of this will be supplied to any bona fide applicant.

BUSINESS NOTES

AMERICA

A Foreign Order for Falls Hollow Stay-Bolt Iron.—The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, has written us that it has recently received a large order for its hollow stay-bolt iron from one of the largest railway systems in England, the railway company desiring to give this iron a preliminary test, with the view of its adoption on the entire system.

A prominent concern in the Middle West advertises that the special tools—not including machinery—cost them $600,000 for the manufacturing of one certain article selling for less than $100. Six thousand special tools, intricate and accurate to the 1/1000 of an inch. This is the modern way of manufacturing, and has been adopted by all leading concerns where quantities of one and the same article are produced. In a modified form this method has been used in the most up-to-date shipyards with great success. The portlights made by C. F. Petersen Company, of 29 South Seventh street, Philadelphia, are manufactured on this principle, all parts are interchangeable, special tools are employed to reduce cost and insure accuracy. A standard model has been adopted, which, through years of actual use, has proved successful. This model was designed by C. F. Petersen, and several times modified to meet the requirements of various demands. In its present shape very few new features have been added. The storm cover, which was formerly cast with strengthening ribs, is made concave, thereby saving weight and improving appearance.

The increasing demand for Bird-Archer boiler compounds in the Orient has necessitated the opening of the following new offices by the Bird-Archer Company, of New York: Honolulu, J. P. Lynch, 42 Young building. Manila, Lambert Springer Company, 99 Plaza Santa Cruz. Yokohama, T. M. Laflin, Exchange Market. Hongkong, Shanghai, Singapore, United Asbestos Oriental Agency, Ltd. All of these agents have competent steam engineers to direct boiler owners in the proper use of the compounds. Recent sales of Bird-Archer Compound in Japan, China and the Settlements have been constantly on the increase in spite of strong competition and prejudice in favor of European, especially English products. These American compounds first gained their prestige in the Orient through their ability to overcome successfully the severe conditions met with in the Philippine Islands, where magnesium and other sulphates in the boiler feed-water have always caused serious trouble. It is said that no other compounds had been found that were able to counteract these scale-forming elements without injury to the boilers. The presence of obstinate impurities and scale seems to be a characteristic of the average steam plant in China, and Japan also, and carefully prepared compounds have proven beneficial beyond question.

OIL-BURNING EQUIPMENT.—Tate, Jones & Company, Inc., Pittsburg, Pa., have received an order, through the Erie City Iron Works, from the Union Pacific Railway Company, at Omaha, Neb., for a complete oil-burning equipment, to be used in connection with Erie City "Economic" boilers.

VESSELS CLASSED AND RATED by the American Bureau of Shipping, 66 Beaver street, New York, in the *Record of American and Foreign Shipping:* American screw, *General Harvey Brown;* American screw, *General G. W. Jetty;* American screw, *General J. M. Brannan;* Mexican screw, *Olympia;* American screw, *General A. M. Randol;* American screw, *General R. H. Jackson;* American screw, *Joseph Henry;* American screw, *Gussie;* American schooner, *Florence M. Belding;* American schooner, *Esther Ann;* American tern, *Josephine;* American tern, *Warner Moore;* American tern, *Frank E. Swain;* British tern, *P. J. McLaughlin;* American tern, *Zaccheus Sherman;* American brig, *Hammond;* American brig, *Richardson,* and American brig, *City of San Antonio.*

THE INCREASING DEMAND for the Blackburn Smith feedwater filter and grease extractor has made it necessary for the manufacturers, James Beggs & Company, of New York, to appoint sales agents in all the principal cities. This filter may now be obtained through the following agents, all of whom have competent engineers to explain its operation and the advantages obtained by its use: Boston, Mass., Walter G. Ruggles Company; Watertown, Conn., M. J. Daly & Sons; Buffalo, N. Y., Buffalo Mill Supply Company; Pittsburg, Pa., National Valve & Manufacturing Company; Cincinnati, Ohio, Murdock Manufacturing & Supply Company; Detroit, Mich., A. Harvey's Sons Manufacturing Company; St. Paul, Minn., R. B. Whitacre & Company; San Francisco, Cal., Plant Rubber & Supply Company. Canada: Montreal, H. W. Petrie of Montreal, Ltd.; Toronto, H. W. Petrie, Ltd.; Vancouver, B. C., H. W. Petrie, Ltd. Porto Rico: San Juan, Lebedjoff & Company. South America: Georgetown, British Guiana, W. G. Harry & Company. The Blackburn Smith filter first became popular for removing oil from the condensed exhaust steam where this condensation must be fed back to the boilers. The filter has been found very effective, and is now widely used for the removal of oil from hot-well water, open heater returns, etc. It is also efficient in removing mud, slime and organic impurities in suspension in the water supply.

THE MIANUS MOTOR WORKS, Mianus, Conn., manufacturer of the Mianus marine gasoline motors, announces the removal of its Providence branch from 139 Richmond street to 142-144 Dorrance street, Providence, R. I. This change was necessitated owing to the former quarters being inadequate to take care of the company's rapidly growing business. A full line of motors and parts will be carried in stock.

THE EUREKA FIRE HOSE MANUFACTURING COMPANY, New York, writes us: "On April 13, about 5.05 P. M., we received a telephone message, requesting us to ship 5,000 feet of Paragon fire hose, complete with couplings, at $1 per foot, by express. Notwithstanding the fact that our works closed down at 6 P. M., by running departments overtime we shipped the entire 5,000 feet on the fast New York Central express leaving Grand Central Station at 11.45 P. M. It was necessary to thread 100 sets of couplings, attach them to the hose, and then haul the hose from our works in Jersey City to Forty-seventh street and Madison avenue, New York City, to the American Express Company's receiving station. A universal thread adopted by all fire departments would be a great thing, as with the volume of business we are doing we could carry several thousand sets on hand, and would be able to ship a very large quantity of hose in case of an emergency in a few hours after receipt of order."

CONSOLIDATION of the Welin Quadrant Davit Company and the Lane & De Groot Company. Owing to the large increase in business and the otherwise closely-related interests of the Welin Quadrant Davit and Lane & De Groot Company, it has been found expedient to consolidate the two companies, under the title of Welin Davit and Lane & De Groot Company, Consolidated. The new company is capitalized at $150,000, and the directors are: John McMullen, A. P. Lundin, Ernest Suffern, John C. Silva and William Stevenson. The officers of the consolidated company are as follows: A. P. Lundin, president and general manager; Ernest Suffern, vice-president; John C. Silva, secretary and treasurer. The new consolidated company will conduct its business in the general offices, on the seventeenth floor of the Whitehall building, 17 Battery Place, New York, and the manufactures are to be taken care of at the old Lane & De Groot factory, 305-315 Vernon avenue, Long Island City.

A HYDRAULIC PAINT for the protection of submerged steel, and for steel which is to be imbedded in concrete, is made by the Semet-Solvay Company, Syracuse, N. Y.

MR. L. E. BURTON has been appointed manager of the sales department of the American Blower Company, Detroit, Mich., in the States of Washington, Oregon and Idaho, with headquarters at 388 Arcade Annex, Seattle, Wash.

MR. RUSSELL DALE, formerly sales manager of the Celfor Tool Company, has been appointed Chicago representative of the Carpenter Steel Company, with headquarters in the Commercial National Bank building, Chicago, Ill.

THE INDEPENDENT PNEUMATIC TOOL COMPANY has moved its general offices from the First National Bank building to the new Thor building, 1307 Michigan avenue, Chicago, Ill., where the company has larger space and better facilities for taking care of its increased business.

THE CO-PARTNERSHIP heretofore existing under the name of Wilson & Silsby has been dissolved by mutual consent. The business heretofore carried on under said firm name will be continued by Adrian Wilson, the continuing partner, under the name of Wilson & Silsby. All claims against said partnership will be paid by said continuing partner, and all persons owing said partnership are hereby notified to make payment to said continuing partner.

MR. W. S. ROGERS, president of the Bantam Anti-Friction Company, sailed for Germany on the 29th of April at the invitation of several German makers of balls and ball bearings, to make close connections for the handling of their goods in this country. This means that the Bantam Anti-Friction Company will enter the automobile field with an energy that those knowing Mr. Rogers can appreciate.

THE STEAMSHIPS *Momus, Creole* and *Antilles,* belonging to the Southern Pacific Steamship Company, 120 Broadway, New York City, have been equipped with fire-detecting wire made by the Montauk Fire Detecting Wire Company, 100 William street, New York City. A perfect fire-alarm system, according to this company, consists of the "Quickest" thermostat, used in connection with its fire-detecting wire, such an equipment being especially suitable for steamship dock sheds and railway freight stations.

BUSINESS NOTES

GREAT BRITAIN

LAUNCH OF STEAMSHIP *Turrialba*.—Messrs. Workman, Clark & Company, Ltd., launched from their south yard recently the steamer *Turrialba* of about 5,000 tons gross register, for the Tropical Fruit Steamship Company, Ltd., Glasgow. The new vessel is intended for the West Indian banana trade, and has accommodation for a number of passengers. The holds are divided into eight compartments, all of which are insulated for the preservation of the fruit cargo, fresh-cooled air being delivered through ducts to each compartment by electrically-driven fans. The vessel has been built under the special survey of the British Corporation for their highest class, and both the requirements of the British Board of Trade and the United States Steamship Passenger Inspection Service have been fully complied with. The vessel will be fitted with triple-expansion engines, constructed by the builders, and is designed for a speed of about 15 knots per hour.

RICHARD MORELAND & SON, LTD., give notice that they have removed their engineering works from Old street to Silvertown. Their general offices will still remain at 80 Goswell Road, London, E. C.

CHAIN-DRIVEN WINCHES ARE COMING greatly into use, especially for passenger steamers, for which they have several important advantages, especially their being noiseless. The makers, Messrs. David Wilson & Company, Ltd., Stanley Works, Fulton street, Liverpool, have had recently several important orders. The new steamers being built for the Nelson Line are among others to be fitted, and the powerful Canadian ice-breaker being constructed at Messrs. Vickers', Barrow, is also being supplied with the David Wilson noiseless winch.

"BITUROS" is the name given to a new composition which has been placed on the market by Messrs. Wailes, Dove & Company, Ltd., Newcastle-on-Tyne. This composition has been specially prepared to meet a long-felt want, a composition that will permanently protect from corrosion iron and steel water tanks used for drinking water purposes without imparting to the water any disagreeable flavor or discoloration. The composition is impervious and watertight, and being of an elastic and strongly adhesive nature, will not crack or peel off. Although quite suitable for tepid or distilled the composition is not suitable for hot-water tanks.

MESSRS. BULL'S METAL & MELLOID COMPANY, LTD., Yoker, have got some remarkable results with propellers of their metal fitted to the steamship *Cassandra,* trading between Glasgow and Montreal and St. Johns. The mean results on eight consecutive voyages with steel propellers show a speed of 12.297 knots, as compared with 13.08 knots on five subsequent voyages with Bull's metal propellers, although the revolutions were reduced from 73.2 to 71.7 per minute, and the coal consumption from 86.57 tons to 84.4 tons per day. The average draft on leaving was, however, 23 feet 8 inches, against 23 feet 5½ inches. The firm also record that they have the permission of the owners of the Allan liner *Pretorian* to state that the substitution of their solid propeller for a loose-bladed bronze propeller increased the speed fully three-quarters nautical mile per hour, with reduced revolutions and coal consumption.

ON APRIL 22 the steel screw-steamer *Magdalena,* built by Messrs. Craig, Taylor & Company, Ltd., Stockton-on-Tees, to the order of A. C. Lensen, Esq., of Terneuzen, was taken to sea for her trial trip, which proved highly satisfactory. The vessel is of the following dimensions, viz.: 298 feet by 44 feet by 21 feet 1 inch depth, molded. She is built of steel, to the highest class in Lloyd's registry, under special survey, of the single-deck type, and has water ballast in double bottom fore and aft and in peaks. The accommodation for captain and officers is neatly fitted up in deckhouses amidships, the engineers' being in deckhouse alongside engine casing, and the crew in the poop. She is equipped with patent steam windlass with quick-warping ends, steam steering gear, five steam winches, suitable donkey boiler, screw gear aft, pole masts, electric light throughout and all modern improvements. The machinery has been constructed by the North Eastern Marine Engineering Company, Ltd., the cylinders being 21, 35, 57 by 39, with two large steel boilers working at 160 pounds pressure. During the run from Hartlepool Heugh to Souter Point, everything worked with the greatest smoothness, and a speed of close upon 11½ knots was maintained. The owner, Mr. A. C. Lensen, and Mr. W. C. Carter, of London (superintendent engineer), both expressed themselves as being highly pleased with the ship and engines.

MESSRS. MILLER & MACFIE, LTD., have acquired and turned into a private limited company the business of marine, general engineers and boilermakers, lately carried on by Messrs. Colin Houston & Company, 20 Stanley street, Paisley Road, Glasgow, and the business will now be carried on under the name of Miller & Macfie, Ltd., at the above address.

THE PARKER FOUNDRY COMPANY, LTD., Derby, has appointed Mr. Reginald Willis, of County Buildings, Corporation street, Birmingham, its representative in Birmingham and district, for the sale of its well-known "Tropenas" steel castings and malleable iron castings. The "Tropenas" steel castings machine up clean and sound, and the mechanical test results obtained are such as the British Admiralty and leading London engineers now require.

THE STEEL SIDE-PADDLE RAILWAY-WAGON STEAMER, *Fabius*, built for the Crown Agents for the Colonies, was successfully launched, recently, from the yard of Messrs. G. Rennie & Company, Greenwich. The leading particulars of the vessel are as follows: Length, 160 feet; beam, 33 feet 6 inches; depth, 10 feet; draft, 5 feet 6 inches. The vessel is of the double-ended type, capable of carrying a load of six wagons, 34 tons each and 35 feet 6 inches over the buffers, or four wagons 30 tons each and 42 feet over the buffers, on two lines of rails on the main deck. The hull is entirely built of Siemens-Martin steel, galvanized throughout by the hot process, and is of very strong construction. The whole of the decks, cabins and woodwork are entirely of teak, and there is accommodation for passengers, crew and captain. The vessel is steered by hand and steam-steering gear, and is provided with two warping capstans, one at either end, these capstans being arranged either for hauling wagons aboard or for dealing with the anchors. The heads of these capstans are arranged to sink below the deck, so as to get them out of the way when not in use. The estimated speed of the vessel, with full load of 150 tons, is 7 knots. The vessel is provided at either end with balance rudders, which are constructed of steel plate sheathed with teak, and follow out the lines of the vessel. Special arrangements are made for automatically locking the rudder at either end when not in use, and arrangements are provided on the steam-steering gear for working either rudder independently. The prow is constructed of very strong H-section iron, and connected with tie rods and teak planking on top, and is hinged to the vessel with four large cast steel hinges and pins. Means for raising and lowering the prows are obtained by balance weights, which are provided on long arms entering the forward part of the vessel, and the prows are raised and lowered by means of small hand winches. There are two separate sets of lines for the wagons. These rails are bolted to heavy teak planks, running fore and aft. When the vessel is in use without any wagons on board, means are provided for sinking the vessel to its proper draft by means of a large ballast tank running right fore and aft of the vessel. This tank is divided into seven separate watertight compartments, so that practically any trim can be given to the vessel. This, of course, is most important, in view of the possibility of the vessel grounding on sand banks, etc., and also when the vessel is being loaded with wagons. The tanks are pumped out by means of a centrifugal pump, and as a stand-by a large service pump can be used if necessary. The vessel is very carefully stiffened, fore and aft, under the rails by means of lattice girders. All deckhouses are very carefully protected from the heat and rays of the sun, and each window is provided with fine copper wire netting, proof against sun flies and mosquitos. The whole of the vessel is lighted by electric light throughout, and a very powerful searchlight is situated on the upper deck, to assist in navigating the vessel at night. There are accommodation ladders provided on either side of the vessel, constructed of teak, and all ladders, hatches and skylights will be constructed of the same material. Strong bumping posts are arranged at either end of the vessel. These are made to collapse between the rails when not in use. The vessel is provided with two sets of machinery, one set to each wheel, each set having cylinders 15 and 26 by 36 stroke, and separate boilers. Arrangements are made to couple the two engines together when necessary. The cylinders are arranged diagonally, with only one crank to each set. There is one common condenser, constructed of copper, which has very large cooling surface. The paddle-wheels are fitted with feathering floats of American elm. The air pump is of the Edwards type, worked by a separate engine. This also applies to the circulating, feed and bilge pumps. There is also a feed donkey and large general pump. The vessel and its machinery has been constructed under the supervision of Messrs. R. Elliott Cooper & Frederic Shelford and Messrs. Flannery, Baggallay & Johnson.

MARINE SOCIETIES.

AMERICA.

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.
314 Madison Avenue, New York City.

UNITED STATES NAVAL INSTITUTE.
Naval Academy, Annapolis, Md.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS.
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.
207 Bath Street, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.
St. Nicholas Building, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

GERMANY.

SCHIFFBAUTECHNISCHE GESELLSCHAFT.
Technische Hochschule, Charlottenburg.

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MESSRS. PHILIP & SON, LTD., Dartmouth, have completed the fine screw-tug *Doria* for Mr. W. Watkins, of London, and handed her over after a very satisfactory trial in Start Bay, when a mean speed of 12.666 statute miles was obtained. The following are her chief dimensions: Length between perpendiculars, 96 feet; beam, 20 feet 6 inches; depth of hold, 11 feet 6 inches. She is classed 100 A-1 at Lloyd's. The *Doria* is fitted with engines of triple-expansion surface condensing type, having cylinders 13 inches, 21 inches and 34 inches with 24 inches stroke. The boiler is of cylindrical multi-tubular type, 12 feet diameter by 10 feet long, with a working pressure of 165 pounds. The engines, which are fitted with United States packing, worked during the trial without a hitch. The vessel has steam-starting and reversing gear for the engines, is steered by steam, and has steam windlasses, by Messrs. Clarke, Chapman. She is equipped for long towages, her total capacity for coal being 100 tons. The *Doria*, which is the first of three sister vessels building by Messrs. Philip for the same owner, will no doubt form a valuable addition to Mr. Watkins's already large and powerful fleet. The official trial trip took place on the 20th, but the *Doria* received her baptism on March 11, when, although not finished, the builders took her out to sea during a heavy gale to the assistance of a vessel in distress, which, after some hours' heavy work, they succeeded in bringing into safety. During the service the *Doria* behaved admirably, and although flying light with only a ton or two of coal on board, proved herself a capital sea boat, much to the satisfaction of the builders and also the owner's engineer, who was at the engines the whole time. This, surely, is an unique trial for a tug.

TRADE PUBLICATIONS.

AMERICA

Sirocco blowers, made by the American Blower Company, Detroit, Mich., are described in a booklet this company has just published, and which is handsomely printed and illustrated, like all the rest of this company's literature. Three typical examples, illustrating points of superiority claimed for the Sirocco fan, are worked out by the American Blower Company, from which it will be noted that the advantages claimed may be summarized as follows: Increased efficiency, resulting in a saving in horsepower for the same capacity; increase in capacity of fan for the same power; smaller space occupied for a given capacity, and slower speed, resulting in quiet operation.

A corrugated copper flange gasket is the subject of catalogue 9 issued by the Chapman Engineering Co., Land Title building, Philadelphia, Pa. This is a case-hardened corrugated copper gasket, for which the following claims are made: "It is case-hardened like a piece of steel, and the corrugations will spring or expand and contract in the flange 1/16 of an inch, and the gasket cannot burn or blow out. It has the pores of the metal closed, and for that reason the gasket will neither set nor crack under pressure nor corrode from electrolysis nor the presence of sulphuric acid, and can be used over again. It can be used on superheated steam under the most terrific pressure, and where both pressure and temperature fluctuate violently and frequently, and with equal efficiency and economy on low-pressure work as well. It can be used on steam, water, air, oil, gas, tar, naphtha and glycerine, and under ordinary circumstances will last as long as the pipe. It will make and hold a joint as tight as a bottle, either on a smooth or a rough-faced flange. It is peculiarly adapted for mining purposes, where acid is present in the water and where the lines of pipe are long and the condensation is excessive. It absolutely outclasses all types of gaskets made from toral, soft copper, asbestos and any form of sheet rubber or fibre packing and superheated gum. It is made of the exact size and shape that you order, and you do not have to pay for the materials in the corners, centers or bolt holes, and it can be instantlv applied by removing one-half of the bolts."

Cast, malleable and brass fittings, brass and iron valves and cocks, wrought steel and iron pipe, valves and Stillson wrenches, are described in illustrated circulars distributed by the Walworth Manufacturing Company, 128 Federal street, Boston, Mass.

Plate planing machines for planing boiler plates, etc., made by the Niles-Bement-Pond Company, 111 Broadway, New York City, are described in illustrated circulars this company has just published. The statement is made that these machines will bevel the edge and square up a narrow calking surface with a true finish in much less time than it can be done by hand. Two tools cutting in opposite directions are employed, so that no time is lost on return strokes. The company builds especially designed machines for planing ships' plates

The proper care of belts is described in a pamphlet published by the Joseph Dixon Crucible Company, Jersey City, N. J. Explanations are given as to why belts slip, the results of slipping, pointers about overloaded belts, as well as dirty, tight and slack belts. The Dixon Company prepares two dressings—flake belt dressing and leather preservative, and solid belt dressing. The former is a semi-liquid dressing; the latter is put up in solid sticks. For dried-out, neglected belts the flake dressing should be used, but when a quick, convenient cure for slipping is desired the solid dressing should be applied.

The American engine-room gage boards are described by the American Steam Gauge & Valve Manufacturing Company, 208 Camden street, Boston, Mass., in a pamphlet that this company has just issued. "No engine room is complete without a gage board, mounted with a good clock and gages connected direct to the engine, boiler, heating and other pressures. We make a specialty of this line, and you will find on the following pages a few illustrations of sets which we have recently furnished. The boards we make are fitted throughout with American gages, which are unexcelled for accuracy, wearing qualities and exterior finish. The boards can be furnished in any kind of marble or slate for any number of instruments, and we shall be pleased to submit sketches and estimates on designs to meet any requirements. In asking for estimates, please state whether a plain or fancy board is wanted, also material, number and size of instruments and amount of space available, if it is limited. We also furnish plain and fancy boards of oak, black walnut, cherry, mahogany and cast iron."

"Plymouth Products" is the title of a series of bulletins giving information concerning the Plymouth Cordage Company, North Plymouth, Mass., and its products. These bulletins are bound together in pamphlet form, and should be interesting to all rope buyers. A copy will be sent free to any reader of this magazine upon application.

"Aids to Navigation" is the title of a 30-page illustrated catalogue issued by the Nicholson Ship Log Company, 409 Superior street, Cleveland, Ohio. "The Nicholson recording ship log is a radical departure from all other types of nautical measuring devices. In addition to giving the mileage sailed, it shows the speed per hour on a dial and records this speed on a chart for every minute of the trip. These records can be dated and filed away for further reference, and should any accident or controversy occur, they would furnish incontestable evidence. The successful application of the speed of the moment dial and the record is entirely original with the Nicholson log."

Lunkenheimer steam specialties are the subject of a great number of catalogues and booklets issued by the Lunkenheimer Company, Cincinnati, Ohio, any one of which will be sent free upon application to readers mentioning this magazine. Among the catalogues this company issues are those with the following titles: "Generator Valves," "Safety Valves," "Oil Cups," "Exhaust Pressure Regulators," "Safety Water Columns," Automatic Injectors," "Automatic Cylinder Cocks," "Mechanical Oil Pumps," "Blow-Off Valves," "Specialties for Traction or Portable Engines and Boilers," "Regrinding Valves," "Sand Blast and Air Nozzles," "Grease Cups for Cylinder Lubricators," "Oiling Devices," "Whistles," "Ground Key Work with Special Keys," "H-W Cross-Head Pin Oiler," "Specialties for Automobiles and Motor Boats."

TRADE PUBLICATIONS

GREAT BRITAIN

Electric ventilating fans for use on board ship are described in a catalogue published by the Electric Ordnance Accessories Company, Ltd., Aston, Birmingham. These fans have been especially designed and constructed to pass the tests of the British Admiralty. They are equally suitable for use on the floor, desk, wall or ceiling.

River steamers, dredgers, tugs, lighters, motor launches, engines, boilers, etc., are the subject of a handsomely illustrated catalogue published by Arthur R. Brown, 52 New Broad street, London. Among the interesting photographs of some of this company's steamers are those in use on the Amazon River, in Central America, Brazil, India, Africa and other parts of the world.

Thomas Noakes & Sons, Ltd., contractors to crown agents for the colonies and India, office 4 and 5 Osborn Place, Brick Lane, London, have published a number of circulars describing and illustrating their high-class engine and boiler fittings, reducing valves, safety and relief valves, asbestos-packed cocks, water gages, feed pumps, gunmetal, copper and phosphor bronze castings.

Improved patent oil cabinets are described in illustrated circulars distributed by the Valor Company, Ltd., Rocky Lane, Aston Cross, Birmingham. This cabinet is made of tinned steel with galvanized iron bottom. Being enameled bright red, it is attractive in appearance and is unaffected by weather or the oil. It shuts up and is dust proof, and owing to its double lid is entirely free from smell. The pump is made of polished brass, simple in construction, and it cannot get out of order. It is screwed into place, and can easily be taken out for filling the cabinet from a barrel. The amount of oil contained in the cabinet may be seen by a glance at the measuring rod.

Ward's metallic packing is described in an illustrated circular distributed by S. A. Ward & Company, Broad Street Lane, Sheffield. The manufacturer states that an ideal packing would be a perfectly broad and flat collar, fitting perfectly true to the piston-rod bearing upon the face of a flat covering jointed on the end of a stuffing-box. "No ordinary pressure could pass it, but seeing that it is not practical the next approach to it is Ward's patent anti-friction metallic collar, divided and arranged in such a manner as to overcome the non-practicability of the ideal collar. This packing is largely used by British and foreign governments and in the mercantile marine of many countries."

BUSINESS NOTES

AMERICA

GEORGE D. EMERY & COMPANY, mahogany dealers, have removed their main offices from Chelsea, Mass., to 17 West Forty-second street, New York City.

THE UNITED STATES NAVY DEPARTMENT has just awarded a large contract for Twentieth Century linoleum glue-cement, grade A, to L. W. Ferdinand & Company, 201 South street, Boston, Mass. The manufacturers state that there were two bidders lower than they, so that they are very much pleased with the outcome of the test which the department has been making with the various materials supplied as samples by the various bidders. This glue-cement is stated to be put up ready for use, to be waterproof and not affected by heat or cold. It is especially adapted for attaching oil cloth, cork carpet, corkolin and linoleum to concrete, cement, steel, stone, tile and wooden floors.

WELIN QUADRANT DAVITS have been recently fitted to the following vessels: *Umagaka Maru*, built by the Mitsu Bishi Dockyard & Engine Works, Nagasaki, Japan, for the Japanese Government, 8 sets; *Star of Canada*, building by Messrs. Workman, Clark & Company, for J. P. Corry & Company, 3 sets; turbine steam yacht *Triad*, building by Caledon Shipbuilding & Engine Company, for G. A. Schenley, 4 sets; *No. 428*, building by A. McMillan & Son, Ltd., for Henry Burrell, 1 set; United States Revenue Cutter *Androscoggin*, building by Pusey & Jones Company, 2 sets; steamship *Espagne*, building by Chantiers & Ateliers de Provence, for Cie. Gen. Transatlantique, 16 sets; steamship *Tambora*, building by Kke My de Schelde, 8 sets; steamships *Nos. 461, 462* and *463*, building by Fairfield Shipbuilding & Engine Company, for Zeeland Stoomvaart Maatschappig, each sets; steamship *No. 468*, building by Fairfield Shipbuilding & Engine Company, for Union Castle Mail Steamship Company, 16 sets; steamship *No. 410*, building by Harland & Wolff, Ltd., for Union Castle Mail Steamship Company, 16 sets; steamship *No. 121*, building by Newport News Shipbuilding & Dry Dock Company, for Matson Navigation Company, 10 sets. These davits are made by the Welin Quadrant Davit, Inc., 17 Battery place, New York, and Axel Welin, 5 Lloyd's avenue, London, E. C.

THE FALLS HOLLOW STAYBOLT COMPANY, Cuyahoga Falls, Ohio, has recently appointed the following sales agents: Brydges Engineering & Supply Company, 249 Notre Dame avenue, Winnipeg, Canada; Mussens, Ltd., 299 St. James street, Montreal, Canada, and J. H. Skelton & Company, Royal London House, Finsbury Square, London, E. C., England.

OAKITE, made by the Oakley Chemical Company, 114 Liberty street, New York City, is stated to be of special value on shipboard for cleaning waste and saving the oil therein, so that it may be repeatedly re-used; for cleaning machinery, engine-room floors, etc.; for cleaning overalls, jumpers and caps; for swabbing decks, washing floors, and in the steward's department for cleaning dishes, glassware and cooking vessels. A chemical analysis of lubricating oil and waste made before and after the use of Oakite shows that both are unchanged, according to the manufacturer.

THE DETROIT SEAMLESS HOLLOW STAY-BOLT, made by the Detroit Seamless Steel Tubes Company, Detroit, Mich., is, according to the maker, a product of the highest excellency, being made from the best grade of basic open-hearth steel, ensuring wonderful ductility, great tenacity, flexibility and high tensile strength. This is manufactured by the seamless process, in which the tube is rolled over various mandrels, compressing and combining the metal from the inside as well as the outside, thereby giving the steel, according to the manufacturer, those desirable qualities resulting from great density and preventing objectionable welds. These stay-bolts are stated to be especially desirable for locomotive, marine and other types of boilers.

EQUIPMENT FOR NAVAL COLLIERS.—The American Steam Gauge & Valve Manufacturing Company, 208 Camden Street, Boston, Mass., has recently furnished the following equipment for the three new colliers built by the Maryland Steel Company: Eighteen American Thompson improved indicators, three 10-inch chime whistles, three 6-inch siren whistles, twelve 3½-inch duplex pop safety valves, three 2-inch single-pop safety valves, eighteen steam and water relief valves, twelve cylinder relief valves, fifty-two gauges, three clocks, six counters; and has also furnished the following for the *North Dakota*, built by the Fore River Shipbuilding Company: Six clocks, one hundred and eight steam and vacuum gauges, two counters and sixty-eight valves.

BUSINESS NOTES

GREAT BRITAIN

ELLIOTT BROTHERS, 36 Leicester Square, London, E. C., call attention to the fact that they are now making in their factory at Lewisham, precision micrometers, which they state it has heretofore been necessary to import from abroad.

A FREE SAMPLE TIN of Palfreyman's rust preventative will be sent to any reader mentioning this magazine upon application to W. H. Pelfreymen & Company, 17 Goree-Piazzas, Liverpool. This rust preventative is stated to be especially adapted for coating the bright parts of engines, machinery, tools, grates, instruments, etc.

LAUNCH OF THE STEAMSHIP *Boscawen*.—On the 6th of April, Messrs. Craig, Taylor & Company, Ltd., launched from their Thornaby shipbuilding yard, Thornaby-on-Tees, a finely-modeled, single-deck screw steamer of the following dimensions: 290 feet by 40 feet 9 inches by 20 feet 6 inches molded. She is built of steel to the highest class in Lloyd's, under special survey, and has poop, bridge and topgallant forecastle, water ballast in double bottom, fore and aft, and in peaks. She is equipped with patent steam windlass with quick-warping ends, steam steering gear, four steam winches, and suitable donkey boiler, pole masts, to Manchester Ship Canal requirements, large hatches and all the latest improvements for rapid loading and discharging. The accommodation for captain and officers is neatly fitted up in poop, the engineers' being in deckhouse alongside engine casing, and the crew in the forsecastle. Her engines have been constructed by the North Eastern Marine Engineering Company, Ltd., Sunderland, the cylinders being 21½, 36, 59 by 39, with two large steel boilers working at 180 pounds pressure. The vessel has been built to the order of Messrs. E. Jenkins & Company, of Cardiff, under the superintendence of Messrs. N. T. & F. G. Daniel, of Cardiff.

LAUNCH OF A PATENT TRUNK STEAMER AT STOCKTON.—On May 20, Messrs. Ropner & Sons, Ltd., of Stockton-on-Tees, launched from their yard a steel screw steamer of the following dimensions, viz.: Length, 378 feet 6 inches; breadth, 53 feet; depth, 27 feet 3 inches. The vessel is built to the highest class in the British Corporation Registry to carry about 7,900 tons, she is for foreign account and is fitted with the builder's patent improved trunk deck, with two large clear holds, and two only, large hatchways, one being 82 feet long by 26 feet wide, and the other 67 feet long by 26 feet wide, thus facilitating rapid loading and discharging. The saloon, with accommodation for captain, officers and engineers, is fitted up in deck houses amidships on trunk deck, with the crew in the forecastle. The vessel is built on the deep-frame principle, the frames being of bulb-angle steel, and the holds are clear of all obstructions to the stowage of cargo, there being no hold beams or wide stringers. She has capacity for about 1,500 tons of water ballast in her cellular bottom and peak tanks. Her measurement capacity is exceptionally large and she is fitted with nine powerful steam winches working in conjunction with ten derrick posts arranged in pairs, with wire runners and purchase spans. Steam is supplied to the deck machinery by a large horizontal multitubular boiler 11 feet by 10 feet. The outfit includes stockless anchors, quick-warping steam windlass, steam steering gear amidships and powerful screw gear aft. The engines are of the triple-expansion type by Messrs. Blair & Company, Ltd., of Stockton-on-Tees, of about 1,800 indicated horsepower on a very full specification, with boilers 16 feet by 9 inches by 11 feet by 6 inches, working at a pressure of 180 pounds.

TRADE PUBLICATIONS.

AMERICA

Regulating appliances are the subject of a very complete and fully illustrated catalogue of 178 pages just issued by the Mason Regulator Company, Boston, Mass. This concern makes regulating devices of all kinds, and the catalogue should be extremely useful to all users of regulators. The aim of the designer of the Mason regulator has been to produce simple, practical regulators of the best material and workmanship, and neither time nor money has been spared to make them perfect. The company solicits correspondence from persons who have difficult or peculiar problems of regulation to solve.

The "Positive" water glass guard is described in illustrated circulars issued by the American Steam Gauge & Valve Manufacturing Company, 208 Camden street, Boston, Mass. "The Positive guard consists of two frames or doors of malleable iron swinging on hinges attached to a bracket secured to the boiler head by studs. The doors completely cover the water glass, and stand at such an angle with the boiler head that the light is reflected through sight glasses. The sight glasses are made of heavy plate glass with woven wire insert, and placed in slots in each door directly in front of water glass, giving perfect view of water level at all times. The Positive guard will save eyes and prevents law suits. The Positive guard on application becomes a permanent fixture on the boiler head and cannot be thrown away or lost. It lasts as long as the boiler head and costs nothing for renewals. It saves train delays caused by the inability of the enginemen to locate and shut off cocks. With the Positive guard the cocks can be found immediately and closed with bare hand. The Positive guard saves time when renewing water glasses, there being no parts to remove or lose. After glass is applied, cocks may be opened quickly with absolutely no danger to workman. The Positive guard necessitates no change in water glass fixtures, and can be applied to any boiler head at an infinitely small cost. When ordering, give distance from boiler head, or lagging, to center of water glass. If head is lagged give thickness of lagging. Also distance between packing nuts and diameter of same."

"Cork; Its Origin and Uses," is published in pamphlet form by the Armstrong Cork Company, Pittsburg, Pa. This is an illustrated booklet telling of the origin of cork, the process employed in its manufacture, and its varied uses. Handsome half-tone illustrations add much to the interest of the story.

Eureka packings are described in a handsomely illustrated catalogue issued by the Eureka Packing Company, 78 Murray street, New York. The catalogue states that Eureka packing was first brought into use by the genius of a marine engineer nearly thirty years ago. Having tried all kinds without good results he resorted to braiding flax by hand over a rectangular strip of rubber, and soaking it in lubricants. Its success under the most trying conditions was phenomenal, and to-day the same principle is carried out by machinery. It is made in many styles and sizes, and for all pressures for steam, water and ammonia.

Automatic controlling valves are described and illustrated in a pamphlet published by the Ideal Automatic Manufacturing Company, 125 Watts street, New York City. "The Ideal automatic pump governor is an oil-controlled piston actuated pressure-controlling valve for governing pumps working under a specified pressure pumping air, oil, salt or fresh water, ammonia, etc., and is so sensitive in its operation that the slightest break in the pressure will immediately start opening the valve, thereby supplying steam to the pump. The Ideal governor will prolong the life of the pump by preventing it from doing unnecessary work, causing unnecessary wear and tear and useless waste of fuel, as would be the case if the pump were equipped with a relief safety by-pass valve. For marine uses the Ideal governor is the only pump governor that has ever been approved by the National Board of Supervising Inspectors of Steam Vessels and by the United States navy, and may be used aboard ship on the salt-water fire pumps, salt-water sanitary pumps, feed-water pumps, fresh-water pumps, pumps for hydraulic purposes and ash pumps. For stationary or land uses the Ideal governor is adapted for all kinds of pumps, including elevator pumps, turbine step-bearing pumps, automatic fire sprinkler systems, ammonia compression engines, compressed air or gas machines, hydraulic apparatus, fire engines, hydraulic rams, or, in fact, any apparatus requiring an automatic pressure controller."

The Reeves-Graef marine engines, "built for hard service," are described in an illustrated pamphlet published by the Trenton Engine Company, Trenton, N. J. These engines were designed by E. W. Graef, who has had years of experience in marine engines for all service. The manufacturer makes special claims for these engines as to their simplicity, lubrication, quiet running and economical fuel consumption.

Pumping machinery is described in pocket-size bulletin No. 10 published by the C. H. Wheeler Manufacturing Company, Philadelphia, Pa. In this catalogue are illustrated the most recent developments in the company's machinery. This concern manufactures steam, electric and power-driven pumps, both for pressure and vacuum. Each machine is carefully designed and proportioned to perform its duty with the greatest possible efficiency, a constant basis being adopted for rating all apparatus. The construction and finish are on high-class engine lines, while particular attention is given to the thorough testing of all parts as well as the complete machinery. The C. H. Wheeler Manufacturing Company also manufactures surface, jet and barometric condensers and water-cooling apparatus. Bulletins describing any of these will be sent free upon request to readers mentioning International Marine Engineering.

Plate working tools are described in a handsomely illustrated catalogue just issued by Wickes Bros., Saginaw, Mich. The tools therein illustrated were designed for use in their own plant, and are now offered to the trade with the assurance, based on experience, that they will prove efficient, durable and satisfactory under the trying conditions of the ordinary boiler shop or other plate-working plants. Wickes Bros. state that following a continuous experience of annoyances, failures and break-downs with tools made by other concerns, they were led to design machines that would prove durable and satisfactory, even when operated by inexperienced labor, and that they succeeded so well that others asked them to build similar tools, which met with so much favor that these have now been placed on the market. Among the tools described are plate bending rolls; steel frame bending rolls, motor driven and engine driven; special bending rolls with wench for shipyards; belt-driven bending rolls; vertical rolls, engine and motor driven; angle bending rolls; plate planers, punches and shears; gang punches; rotary shears, hydraulic riveters and flanging presses; boiler-head facing machines; flanging clamps and many others.

A valuable catalogue of drop forgings, a free copy of which will be sent free upon application to any reader who will mention this magazine, has just been issued by J. H. Williams & Company, Brooklyn, N. Y. The front cover design is very striking, being a facsimile in colors of a red-hot drop-forged wrench. In this catalogue are listed about 800 assorted sizes of forty patterns of wrenches, with a range of opening for every size of bolt from ⅛ inch to 5 inches, inclusive. Several new lines are shown which have been brought out since the last catalogue has been issued, among them being "Vulcan" bijaw chain-pipe wrenches, "Agrippa" fittings, chain wrenches, planer clamps, lathe dogs, with two screws, flat-handle S wrenches, and wrench sets in canvas rolls. For the convenience of the customer in checking invoices there is published a numerical index of wrenches, affording the means of locating a given index page or establishing identities when numbers only are given in the invoice. The catalogue calls especial attention to the Williams chemical and physical testing laboratory, which has grown largely during the past few years. While it is equipped to make general metallurgical analyses, the company employs it principally for the purpose of assuring itself that the material used in its forgings is within the chemical specifications of its customers. This at times means a separate analysis of each bar in a shipment of raw material from the mill, and in every case a sufficient analysis is made to assure th ecompany that the steel supplied to fill all orders is of uniform character and well within the desired chemical limits. The demands of the customers of J. H. Williams & Company, and of its own product, have led to constant improvement in its annealing, carbonizing, case hardening and tempering departments, so that it is exceptionally well equipped to care for this class of work in a manner that could not be considered for a smaller volume of business. The furnaces are fitted with recording pyrometers, so that perfect control can be had of the heating of the steel and at the same time retain the record for future references. This concern also makes a specialty of drop forgings made to order for a variety of purposes; for gas engines, locomotives, machine tools, steam pumps, injectors, chucks, air compressors, boiler makers' tools, hydraulic and lever jacks, marine specialties, pipe cutting and threading machinery, steam engines, etc. A reduction of this catalogue will be issued in a 4-by-6-size, affording a pocket-carrying size that will be appreciated by many.

Ventilation in engine rooms, boiler rooms, motor boat cabins, etc., is described in Bulletin No. 90 published by the B. F. Sturtevant Company, Hyde Park, Mass.

A number of interesting pocket-size catalogues have recently been issued by the American Blower Company, Detroit, Mich., any one of which will be sent upon application to readers of this magazine. "Ventilating and cooling" should prove of special interest at this time of the year. The company makes a specialty of the ventilating and cooling of engine rooms, ships' holds, etc. *Sirocco* is another of these booklets which states that the Sirocco fan is valuable for ventilation, cooling and mechanical draft aboard ship. In *A Hand-Book of Information* the American Blower Company gives considerable information regarding its exhausters and blowers.

Cut meters are made by Schuchardt & Schuette, 90 West street, New York, and are described in an illustrated catalogue this company is issuing. The catalogue states that these meters are practically the only instruments which can be relied upon without using a watch for instantaneous and accurate readings of the rate of cut in any direction; that they are indispensable for milling tools, periphery speeds of drills, belt speeds, hoisting speeds, etc., as they render it possible to obtain the full output from machinery and machine tools, and that as the readings do not depend upon magnetic action the instruments remain accurate under all shop conditions; that they are not delicate tools requiring scientific handling, but are essentially shop tools for machinists' use.

Harbar craft, building and repairing, and marine machinery are the subject of an illustrated catalogue just published by Waters, Gildersleeve, Colver Company, successor to F. A. Verdon Company, West New Brighton, Staten Island, N. Y. The water frontage of this concern is 618 feet. The piers are large, and over 300 feet in length, and the depth of water is from 12 to 24 feet, thus insuring the quick handling and repair of tugs, canal boats, lighters, barges and all other harbor vessels. The blacksmith, boiler, machine, pattern, carpenter and joiner shops are all on the piers and platforms, and with the drydocks, shipbuilding platforms, electric cranes and derricks, every needed facility is here for proper construction and repair work. The drydocks are suited for boats 225 feet in length and smaller.

TRADE PUBLICATIONS

GREAT BRITAIN

Yacht fittings are described in a catalogue published by Simpson, Lawrence & Company, 11 St. Andrews Square, Glasgow. This concern is prepared to furnish yachts with such fittings as anchors, windlasses, chains, blocks, barometers, lamps, stoves, paint and varnish, paneling, hinges, racks, cupboards, etc.

Galvanic metal packings are the subject of circulars issued by W. Christie & Company, 50 Wellington street, Glasgow. "The packing being fitted in a conical or funnel shape, becomes automatic to the pressure of steam, the inner edge being pressed against the rod and the outer one against the wall of stuffing-box. After the engines have been running a short time the packing will become compressed by the pressure, and will, consequently, become loose in the stuffing-box. The gland must be at once tightened, and this operation repeated a few times until the packing becomes settled. The metal packing rings consist of a series of thin rings of galvanic deposits of nickel and copper, sewn together in sections of 1/4 to 3/4 of an inch deep."

A price list of nautical surveying and mathematical instruments has just been issued by Heath & Company, Ltd., Crayford, London. This catalogue, which has been in preparation for several years, should prove of great interest to the trade. Messrs. Heath & Company have for a long time supplied some of the leading governments with all of their surveying instruments and accessories. A free copy of this booklet will be sent upon application to all of our readers who will mention INTERNATIONAL MARINE ENGINEERING. Among the instruments described and illustrated are binnacles and compasses of various types, sounding machines, barometers, heliographs, naval plotoscopes (this latter instrument is for plotting the exact positions of submerged mines), signaling lamps of many kinds, telescopes and range finders, thermometers, measuring tapes and many others.

BUSINESS NOTES

AMERICA

THE AMERICAN STEAM GAUGE & VALVE MANUFACTURING COMPANY, Boston, Mass., has received from the Newport News Shipbuilding & Dry Dock Company, an order for eight government composition triplex safety valves for torpedo boat destroyers *Roe* and *Terry*. A similar order has been received from the William Cramp & Sons Ship & Engine Building Company for eight triplex valves for torpedo boat destroyers Nos. 30 and 31.

A MARINE CANOE GLUE, which is guaranteed to be waterproof, is made by L. W. Ferdinand & Company, 201 South street, Boston, Mass. The claim is made that its peculiar properties are those of flexibility and durability, and although it becomes soft and pliable under heat it still retains its adhesion to timber, fiber, etc., and is clean and insoluble in water. It is also stated that any puncture or leak in a boat or canoe can be repaired in five minutes with this glue.

THE FOLLOWING VESSELS have recently been classed and rated by the American Bureau of Shipping, 66 Beaver street, New York City: American screw, *Theodore H. Wickwire;* American screw, *Clifford F. Moll;* American screw, *Julia Luckenbach;* American screw, *General J. M. Schofield;* American screw, *John J. Barlum;* American screw, *General R. T. Frank;* American schooner, *William K. Park;* British schooner, *Boniform;* American tern, *Donna T. Briggs;* American tern, *L. N. Dantzler;* British tern, *Waegwoltic;* British tern, *Eva C.;* American tern, *Richmond;* American tern, *Oscar G.;* American tern, *Richard W. Clark;* American tern, *Carrie A. Norton;* American tern, *Harry W. Haynes;* American brig, *Harry Morse*, and Swedish brig, *Swartvik*.

H. W. JOHNS-MANVILLE COMPANY'S EXHIBIT at both the Wisconsin and the Indiana local conventions of the National Association of Stationary Engineers, recently held at La Crosse and at Evansville, consisted of a large line of packings. Although for many years this company has been among the largest packing manufacturers in the United States, their line of packings has been more than doubled within the past year. There is perhaps not a style or type of packing on the market that they do not now manufacture. At La Crosse, Mr. Frank T. Guta represented the company and was also a delegate to the convention from Milwaukee. Mr. C. S. Padgett, manager of the Milwaukee packing department, and Mr. W. F. Taylor were also at the exhibit. The Evansville convention was in charge of Mr. H. H. Lawson and O. E. Wehr, both from the Milwaukee branch.

SOME SATISFACTORY BOILERS.—The Kingsford Foundry & Machine Works, Oswego, N. Y., makers of marine and stationary boilers, have received the following letter from the Garlock Packing Company, Palmyra, N. Y.: "We are in receipt of your valued favor of the 4th inst., relative to the four internally-fired boilers which you have built for us. In reply thereto we beg to advise that we esteem it a privilege to assure you that we are highly pleased with them in every way. Not having ordered them all at one time it goes without saying that the placing of the orders for the last two installed was influenced largely by our unqualified approval of the first boilers ordered and the economical and reliable service received therefrom. We cheerfully recommend your product to any prospective customers, and hereby authorize you to use us in your reference to those who are pleased with the results obtained from internally-fired boilers."

THE B. F. STURTEVANT COMPANY, Hyde Park, Mass., announces the removal of its New York offices from 114 Liberty street to 50 Church street.

MR. BENJAMIN WHITTAKER has resigned as treasurer of J. H. Williams & Company, drop forgings, Brooklyn, N. Y., and will now give entire time to the exporting business for the same company and others, with headquarters at No. 17 State street, New York.

YACHT BOILERS.—Lloyd's *Register* for 1908 lists 505 steam yachts with 600 boilers, and of these boilers 126 were made by the Almy Water Tube Boiler Company, Providence, R. I. In the *American Yacht Register* of 1891 only three out of 348 yachts were equipped with Almy boilers.

MR. J. P. HILANDS, who for a number of years has been in the employ of the National Tube Company at its New York sales agency, has resigned and associated himself with Messrs. Olin & Giberson, and will represent the Ohio Seamless Tube Company in the Eastern territory, with offices in the United States Express Building, No. 2 Rector street, New York.

Large Orders for Valves.—Last January we referred in our columns to the fact that the Lunkenheimer Company, Cincinnati, Ohio, had received from the Panama Canal Commission a large order for "Renewo" globe, angle and cross valves. The order at that time covered upwards of 7,000 valves. Within the past two weeks this company received an additional order for "Renewo" valves amounting, in all, to about $50,000. The "Renewo" valve has a renewable, self-cleansing seat, and the disc can also be replaced when worn. Owing to the ingenious construction of the seating faces the seat will outwear many discs. It is not necessary in every case to replace these parts, as the regrinding feature (which the Lunkenheimer Company is said to have originated, and which has been featured by them for many years in another valve construction) is also embodied in the "Renewo" valve, so that if desired the seating faces can be reground and made tight without removing the valve from connecting pipes. This device is worthy of the investigation of engineers generally, and the Lunkenheimer Company at Cincinnati, or their branches in New York, Chicago or Boston, will be glad to supply full particulars.

BUSINESS NOTES

GREAT BRITAIN

The Mork Patent Pulley Block Company, 42 Moor Lane, London, E. C., states that the "Mork" is the quickest worm gear block made, and that the releasing gear enables the operator to raise or lower the bottom hook in a few seconds.

The Dryad cane furniture, which initiated the new style and methods of workmanship in first-class cane work, has recently been favored with an order from the Orient Steamship Company for chairs for their new ships, after having been put through a severe test by the company.

We understand that Messrs Telford, Grier & Mackay, Ltd., patent signal lamp makers and electrical engineers, Glasgow, have received an order to supply the whole of the British fleet with their new patent flashing signal lanterns, which have also been adopted by some of the principal shipping companies. The principal features of this lamp are: A brilliant light from mineral oil without the use of any glass chimney or other device to take the place of glass chimney; a flashing screen giving full beam of light, full depth and length of the lens at each depression of the Morse key.

MARINE SOCIETIES.

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.
314 Madison Avenue, New York City.

UNITED STATES NAVAL INSTITUTE.
Naval Academy, Annapolis, Md.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS.
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.
207 Bath Street, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

GERMANY.

SCHIFFBAUTECHNISCHE GESELLSCHAFT.
Technische Hochschule, Charlottenburg.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION

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Reduction in Prices of Tantalum Lamps.—We have received a new list from Messrs. Siemens Bros. Dynamo Works, Ltd., Tyssen street, Dalston, dealing with the various types of Tantalum lamps now on the market, and announcing reduction in prices. The list illustrates the well-known Tantalum high-voltage lamps, which are now to be sold at the exceptionally low price of 3/6 in bell-shaped bulbs, and 3/9 in spherical bulbs. This spherical lamp is a new departure, and should meet with popularity. Further, standard bell-shaped or spherical Tantalum lamps of 50-80 volts, 12 and 16 candle-power, are now to be sold at 2s. each. The price sheet also shows illustrations of a new Tantalum candle lamp, which is supplied for 24-40 volts and 5 and 10 candle-power. These lamps should find a ready acceptance generally for use with candelabra fittings, designs and prices of which we hear can also be had from Messrs. Siemens Bros. Tantalum lamps are too well known for us to make any remarks on their excellent qualities, but we learn that the new factory at Dalston, opened some months ago, has great facilities for the manufacture of these lamps, and that rapid progress has been made is obvious from the foregoing reductions in price.

TRADE PUBLICATIONS.

AMERICA

The Welin Quadrant Davit Company and Lane & De Groot Company, Con., 17 Battery Place, New York City, are sending out a postcard photograph of the new 27,000-ton North German Lloyd steamship *George Washington*, which is fully equipped with the Welin quadrant davits. These davits are manufactured in twenty distinct types and sizes, and will handle anything from a 20-foot dinghy to a second-class torpedo boat.

A new chain pipe wrench is described in 1909 catalogue E published by J. H. Williams & Company, Brooklyn, N. Y. This chain wrench is very compact, when folded occupying a space of only 6 by 8 by 8. The action is particularly rapid; the grip is positive, non-crushing, and always renewable by filing the teeth; the chain hugs the pipe half-way round and can't crush. The jaws are all wrought steel, drop-forged, saw-tempered, with hand-made "Vulcan" chain pipe wrench chains. The parts are all warranted and interchangeable.

Steel plate marine ranges are described in illustrated circulars issued by Hutchinson Bros., 5 South Howard street, Baltimore, Md. Following are a few of the many ships recently fitted out with this company's marine ranges: The naval colliers *Mars, Vulcan* and *Hector,* the destroyers *Whipple, Warden* and *Truxton,* the seagoing dredges *Ancon* and *Culebra,* the lighthouse tenders *Maple, Holly* and *Violet,* the training ships *Monongahela, Severn* and *Chase;* also the following merchant vessels: the *Gloucester, Lexington* and *Frederick,* belongong to the Merchant & Miners' Transportation Company; the *Brookline,* of the United Fruit Company, and a great many others.

Low-speed steam turbines, for belt or direct-connected service, are described in illustrated catalogue 3 published by the Terry Steam Turbine Company, 90 West street, New York City. The designer of the Terry steam turbine had in mind two essential features: First, to produce an efficient, small, low-speed machine, and, secondly, that it should be one of the very simplest design. The unusual low speed of the Terry turbine is said to permit direct connection without the usual attendant troubles, and at the same time to eliminate the use of gears. For direct-connected sets up to and including 300 kilowatts, this turbine is stated to have been very successful. The low speeds eliminate the commutating troubles usually found on direct-current turbine generators. The regulation is as close as is obtained in the best engine practice, and fluctuating loads are easily handled. The Terry turbine has also been successfully applied during the past four years for driving centrifugal pumps of single and multiple stage. The range of conditions in this service varies from large volumes of water pumped against low heads, such as circulating water for condensers, up to high head work, such as boiler feed or fire service, where the turbine runs at high speed driving a multiple-stage pump.

Duval metallic packing is described in a catalogue just published by the Power Specialty Company, 111 Broadway, New York. This company, as the successor of the Duval Metallic Packing Company of America, is the exclusive importer of this braided wire packing, which is manufactured in France. "Duval metallic packing has been used in all parts of the world under the most severe conditions for the last fifteen years. We feel that it needs no introduction to mechanical experts, who have investigated the highest class of packing obtainable. The uniformly satisfactory service which it has given under the most strenuous conditions, proves it to be the best metallic packing made. Radical changes have been made in power-plant machinery in the last decade. High-pressure steam has almost entirely replaced low-pressure service. Superheated steam is being generally used. The internal combustion engine has proved practical. Enormous hydraulic pressures are now carried. All of these improvements have demanded the most exacting performances of packing. The soft compositions of the old days could not meet the new requirements, and engineers have turned to the use of metallic packings, which cannot only meet the increased temperature and pressure, but which are practically indestructible. Of the various metallic packings on the market, the advantages of woven wire are at once apparent. It maintains a tight joint with a minimum friction. Its life is longer than any solid ring or spring packing. It requires no attention or adjustment after being installed. No special stuffing-box is required. It is applied to any box without disconnecting the rod. It retains its lubrication better than any other type. It is not injured by grit or sand. If desired all four sides may be used as wearing surfaces. It may be carried in stock and used as desired."

Fine tools and instruments of precision are described in catalogue 18 L published by the L. S. Starrett Company, Athol, Mass. This is a very complete and fully illustrated volume of 232 pages, and should be in the hands of every user of mechanical tools. A free copy will be sent to any of our readers upon request.

Steam turbines for direct connection to generators, blowers and pumps are described in an illustrated pamphlet issued by the E. W. Bliss Company, 17 Adams street, Brooklyn, N. Y. The statement is made that on account of its simplicity the cost of the Bliss turbine is reduced to a minimum, and that it runs almost noiselessly without any perceptible vibration. Besides, on account of its light weight, it requires no expensive foundation.

A new differential steering gear is described in a catalogue published by the American Ship Windlass Co., Providence, R. I., and Williamson Bros.' Company, Philadelphia, Pa. The statement is made that this device includes the following improvements: Variable speed of rudder at different points; greater power when most needed; increased economy and least possible amount of lost motion; small deck room and the fact that it is self-contained and easily installed.

The tachometers and tachographs made by Schuchardt & Schuette, 90 West street, New York, are made to indicate on a dial or to record on a chart the revolution rate of engine and motor shafts, the speed of fly-wheel peripheries, and all measurements of rotative and progressive speed. The scales are divided for any desired reading, such as revolutions, period, feet, yards, miles or other units at any desired rate of time. These instruments are made in two styles—portable and stationary—and many thousands are in use in machine shops, navy yards, electrical works and other manufacturing establishments.

An equilibrium circulator and steam-heating attachment for circulating and heating the water in steam boilers is described in an illustrated catalogue published by H. Bloomsburg & Company, 425 North Carey street, Baltimore, Md., a free copy of which will be sent to any of our readers upon application. The claim is made that this device increases steaming capacity 5 to 15 percent, that it will reduce or prevent leaks of bottom seams and rivets, pitting and corrosion, wet steam and foaming. Over 500 boilers are equipped with the device, which is approved by the United States Steamboat Inspectors, Lloyds and the Hartford Steam Boiler Insurance & Inspection Company.

The Argo atmospheric sight-feed oil cup is the subject of illustrated catalogues published by the Argo Supply Company, 80 Broad street, New York City. The aim of the inventor was to get a sight-feed gravity oil cup which would not be affected by change of height, temperature, vicidity or minute particles in the oil. That this oil cup is not affected by changes in temperature can be readily seen, according to the manufacturer, because the regulation of the feed is by the admission of air. It is stated that this method of regulating the oil feed was attempted by a great many inventors but with little success, because the amount of air admitted is so minute that it is impossible to construct an air valve with a regulation so fine that it will feed the oil slowly enough for practical purposes. It is also claimed that this oil cup does not vary in its set rate of speed if the oil becomes more or less viscous, and that the lowering of the oil in the reservoir has no effect.

"The Technical Index," a comprehensive record of current technical literature published in Belgium, announces that hereafter it will be represented in the United States by the Geo. H. Gibson Company, Tribune building, New York City. *The Technical Index* appears monthly, and gives a systematic descriptive record of all original articles appearing in over 200 engineering and technical journals and reviews, also indexing the proceedings of technical societies and technical books issued in all countries. The method of indexing covers the name of the author, the title of the article in full, an explanatory note stating the contents of the article, the name and date of the publication in which the article appeared and the length of the article. Two editions are printed, one upon both sides of the paper and one upon one side only for card index purposes, and for further convenience all items are arranged according to the Dewey decimal system. Clippings or copies of articles, also books, are supplied by the publishers of the *Index*, the price being indicated in each case. It is stated that over 1,000 original articles are indexed each month, covering all lines of engineering and technology. The American agents offer to send free sample copies upon request, and will also receive orders and subscriptions.

TRADE PUBLICATIONS

GREAT BRITAIN

H. & C. Grayson, Ltd., 21 Water street, Liverpool, have issued a catalogue giving prices and particulars of parafin and petrol engines. Marine and electric sets are listed with engines of the two or four-cycle type.

Messrs. R. Waygood & Company, Ltd., Falmouth Road, London, S. E., have sent us a catalogue of their electric lifts. The firm has supplied over 2,000 of these lifts. The catalogue has a number of very fine illustrations, including examples of electric lifts for liners, which have been supplied to the *Mauretania* and *Lusitania* and other important vessels.

Clarke Crank & Forge Company, Lincoln, have recently issued a catalogue illustrating crank shafts suitable for portable engines, motor launches, etc. The firm make a special feature of forging and machining bent, block or built-up crank shafts in Siemens-Martin or special steels, and they can be supplied either as forgings, rough machined or finished bright.

Tangyes Ltd., Birmingham, have issued literature with reference to their new pump, the "Tan-Gyro," which is of an entirely new pattern, and we understand it is designed to give a high efficiency over a wide fluctuation of duty. It is particularly suitable for emptying docks, feeding canals. etc. Price list No. 321 contains prices for all the different types of these pumps.

Indicators and gages are illustrated and described in trade literature distributed by Buchanan Bros., 16 Carrick street, Glasgow. These catalogues state that Buchanan Bros. have had nearly fifty years' experience in making marine and land engineerinig instruments, and that the accuracy of their various testing appliances is guaranteed by air, water and mercurial tests.

Cranes and transporters for steel works are described in an excellent catalogue recently issued by Messrs. Applebys, Ltd., 58 Victoria street, Westminster, London, S. W. The special cranes illustrated include ladle cranes, forge cranes, fitted with ingot-rotating gear, and also a 4-ton crane for charging soaking pits, designed to work with very limited head room.

"Hints About Case Hardening," what to use, how to do it, is the title of a booklet published by W. H. Palfreyman & Company, 17 Goree-Piazzas, Liverpool, a free copy of which will be sent to any reader of this magazine. The statement is made that the publishers believe this pamphlet contains matter of considerable value to even the most experienced case hardener.

A pamphlet describing the Mirrlees-Diesel oil engine has been issued by Messrs. Mirrlees, Bickerton & Day, Ltd., Hazel Grove, near Stockport. Attention is called to the special features and advantages of these engines, of which we understand a number have been supplied to the British Admiralty for electric lighting on warships, as well as for the propulsion of pinnaces, etc.

A list dealing with Alex. Turnbull & Company's St. Mungo Works, Glasgow, well-known specialties: safety valves, stop valves, steam traps, wrought steel and iron pipes, etc., has recently been issued. The catalogue contains a number of illustrations of the firm's patented specialties for marine and general purposes. Details of manufacture and prices are included in the list, and also a number of testimonials from leading firms where their specialties have been fitted.

Magnesia coverings are described and illustrated in a catalogue just issued by Newalls Insulation Company, Ltd., Newcastle-on-Tyne. This covering has for years been adopted by the British Admiralty for insulating steam pipes and boilers of all classes of vessels, and the statement is made that Newalls' covering is used in more than 95 percent of the warships which have been built in England within the last seven years. Among the well-known merchant vessels equipped with this covering are the *Mauretania* and the *Oceanic*.

Messrs. Siemens Bros.' Dynamo Works, Ltd., have sent us a new list containing particulars of their latest designs of glassware. The book contains a large number of new and select designs of glass shades suitable for high-voltage "Tantalum" or other metal filament lamps, which can be obtained in various styles at remarkably low prices. A number of shades are also shown, suitable for low-voltage "Tantalum" and other metal or carbon filament lamps of low voltage, in opal, satin or crystal etched finish. Special shades, suitable for all classes of interior decorations and electric light fittings, are catalogued at low prices.

Leaflets, giving prices and particulars of gap lathes, high-speed planing machines and plate-bending rolls, are to hand from Messrs. Binns Bros., Water Lane, Halifax.

A sheet, giving dimensions of steel chequered plates of ordinary diamond, Admiralty diamond and oval patterns, has been circulated by the Consett Iron Company, Ltd., Consett, County Durham.

"The Commercial Value of Indicator Diagrams" and instructions for the use of the engine indicator is the title of a booklet issued by Dobbie McInnes, Ltd., 57 Bothwell street, Glasgow. A free copy of this interesting pamphlet will be sent to any of our readers who mention this magazine.

A pocket catalogue of machine tools has recently been circulated by Messrs. H. W. Ward & Company, Ltd., Lionel street, Birmingham. Turret, capstan and other lathes, four-spindle automatic machines, milling, grinding and boring machines and other tools are described and illustrated.

The British Mannesmann Tube Company, Ltd., Salisbury House, London Wall, E. C. A booklet has reached us from this company containing a large number of testimonials relating to the advantages of weldless steel spigot and faucet tubes. We have also received a pamphlet which describes the special features of these tubes and gives full details concerning them.

A list of engineering instruments has been published by Whyte, Thomson & Company, 144 Broomielaw street, Glasgow. This is a new catalogue of indicators and accessories which are especially designed to anticipate the constantly-growing demand for instruments to meet the requirements of present-day engineers.

Messrs. John Cameron, Ltd., Oldfield Road Iron Works, Manchester, recently published a booklet showing several types of ram and piston pumps driven by steam or electric power, and also punching and shearing machines. Among these latter we notice a large four-sided machine for shipbuilders, which is arranged for punching, shearing, angle-cutting and punching side-lights, etc.

BUSINESS NOTES

AMERICA

AT THE RECENT ANNUAL MEETING of the stockholders of the Wheeler Condenser & Engineering Company, held at their works, Carteret, N. J., Mr. J. J. Brown, M. Am. Soc. M. E., was elected vice-president and general manager. Mr. Brown entered the condenser field some fifteen years ago as Southwestern manager for the Henry R. Worthington Company, and later became their general sales manager. After the formation of the International Steam Pump Company he became their general Western sales manager, with headquarters at Chicago, and resigned that position to take up his present work. "The Wheeler Condenser & Engineering Company has recently introduced several important improvements in condensing apparatus, among which are the dry tube surface condenser, which has shown remarkable results in high vacuum work. The company has also in hand new and improved types of rotative dry vacuum pumps, centrifugal pumps, centrifugal jet condensers and cooling powers. The plant at Carteret, N. J., is being enlarged and improved. Among these improvements is a new power house, which will be equipped with several different systems of condensers for exhibition purposes, as well as for supplying the electrical energy which will be used throughout the shop."

THE ALMY WATER TUBE BOILER COMPANY, Providence, R. I., calls our attention to an error made on page 10 of our August issue. The statement is made that of 505 steam yachts with 600 boilers in *Lloyd's Register* for 1908, 126 were Almy boilers. The Almy Water Tube Boiler Company tells us that the total number of Almy boilers should be 196.

HIGH-GRADE IRON FOR STAY-BOLTS, engine bolts, piston rods, forgings, etc., is made by the Carter Iron Company, Pittsburg, Pa. The manufacturers of this iron state that in their opinion some railroads do not pay enough attention to elastic limit of stay-bolt iron; that combined with other essential properties the value of iron allowing an additional strain of 8,000 to 10,000 pounds before permanent set takes place is obvious; the minimum elastic limit of Carter Iron Company's highest grades is said to be 70 percent of the ultimate tensile strength. The Carter Iron Company states that superintendents of motive power have told it that it cost them 40 cents each to take out and replace a broken stay-bolt. The company states that the first cost of its iron is only a small proportion of this, even when its highest quality is used.

New Orders for Welin Quadrant Davits.—The Welin Davit & Lane & De Groot Company, Con., 17 Battery Place, New York City, reports recent orders for complete equipments of Welin quadrant davits for the following ships: Steamships *Bache* and *Patterson*, direct from United States Coast and Geodetic Survey; from William Cramp & Sons, steamships *Ancon* and *Christobal*, of the Panama Railroad & Steamship Company, and for three harbor tugs being built for the United States of America, Quartermaster's Department; from Newport News Shipbuilding & Dry Dock Company, steamships *Bear* and *Beaver*, of the San Francisco & Portland Steamship Company, and for the Matson Navigation Company's new steamer *Wilhelmina;* steamship *Imperial*, of the Standard Oil Company; also for the new oil steamer of the Associated Oil Company. This company is also equipping the tug *Daniel Willard* belonging to the Erie Railroad. Besides these a good many large-sized orders have been received from Europe.

Large Orders for Falls Hollow Stay-Bolt Iron.—The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, writes us: "We are pleased to advise that we are just in receipt of a nice order from the Great Southern of Spain Railway Company, Ltd., for a carload of our hollow stay-bolt iron bars, making the second carload order we have received from this railway company within the past year. The Great Northern Railway recently specified our hollow stay-bolt iron in five locomotives, the American Railroad of Porto Rico in three locomotives being built by the Baldwin Locomotive Works, the Ann Arbor in four and the Detroit, Toledo & Ironton Railroad in eight locomotives recently ordered from American Locomotive Company. During the past six months we have secured fully fifty new railway customers for Falls hollow iron in the United States, Canada and Mexico. We have also received new business from railways in many foreign countries, and have just received an order for a large quantity of Falls hollow stay-bolt iron bars for shipment to the Northern Railway of Costa Rica, at Limon, Costa Rica. Our rapidly-increasing business is the best of evidence that our product is giving the railways the very best of satisfaction. The improved combustion and automatic inspection features appeal to them as advantages that should not be overlooked."

The Phosphor-Bronze Smelting Company, Ltd., 2200 Washington avenue, Philadelphia, Pa., has been succeeded by the Phosphor-Bronze Smelting Company, which latter corporation has assumed the performances and discharge of all the obligations and liabilities of the former company, and will hereafter continue the same business in the same location.

The "Kewanee" Union, made by the National Tube Company, Frick Building, Pittsburg, Pa., is claimed by the manufacturer to have many advantages over other unions, among them being a brass-to-iron-thread connection, which is easy to move, a brass-to-iron-ball seat, which is air-tight without a gasket, and the fact that there are only three solid parts with no brass pieces to drop out.

The transmission dynamometer, invented and patented by Prof. W. H. Kenerson, and illustrated and described by him in a paper read before the meeting of the American Society of Mechanical Engineers at Washington in May, 1909, is a device which indicates by means of a pressure gage the amount of power transmitted through it. The dial on the gage is graduated to show the horsepower per hundred revolutions per minute of the shaft to which the dynamometer is attached. It is said to be sensitive and correct to a degree very closely approximating that of the ordinary gage for indicating pressure, and the construction is such that it cannot easily be deranged. This transmission dynamometer is being built and placed on the market by the Builders Iron Foundry, Providence, R. I.

The B. F. Sturtevant Company Reorganized; capital increased from $500,000 to $2,500,000. "The B. F. Sturtevant Company, a Massachusetts corporation, with a capital of $500,000, has been reorganized and recapitalized. The new corporation is organized under Massachusetts laws with $1,250,000 6 percent cumulative preferred stock and $1,250,000 of common stock, and the stock has all been taken by a few of the large owners. John Carr, chairman of the board of directors of the First National Bank, is president, Eugene N. Foss is treasurer, and E. B. Freeman has been elected general manager. The increased capitalization represents capital expenditures during the past year, largely in the erection of a new plant in Hyde Park which cost over $1,500,000. The B. F. Sturtevant Company has been doing a business of about $3,000,000 a year."

MR. RAY D. LILLIBRIDGE has moved his office to 100 Broadway, and has gone into partnership with Mr. William L. Rickard. The new firm will devote themselves to technical publicity.

JAMES L. ROBERTSON & SONS and the Eureka Packing Company have removed their offices and warehouse from 48 Warren street to new and more commodious quarters at 78 and 80 Murray street, New York.

"LEAK-NO" COMPOUND, made by the H. W. Johns-Manville Company, 100 William street, New York, is stated by the manufacturer to permanently repair leaks in anything made of steel and iron, such as cracks in pump cylinders, repairing spongy spots in iron castings, making flange unions, etc.

MR. C. C. WAIS, the well-known punch and shear manufacturer of Cincinnati, has lately made a business connection with the Covington Machine Company, Covington, Va., which has secured control of his patents on punches, shears and elliptical boring and turning machinery.

PRODUCER GAS OUTFITS FOR MOTOR BOATS.—The Page Engineering Company, manufacturer of gas-power machinery, 113 East York street, Baltimore, Md., has received the following letter from Bar Harbor, Me., from a man who is expecting to build a 75-foot cruiser, and who is only one of many who has expressed much interest in producer gas plants: "Everybody wants a motor boat, and a good many are planning for large motor boats of the cruising type. You ought to publish something soon in one of the yachting magazines about your expectations in the matter of producer gas. I have mentioned it to several, and all say that they are very much interested."

OWING TO the provisions of the new British Patent Act, a novel and important process of steel making is to be introduced, by which the production of malleable and weldable steel castings is made commercially possible. The process is named after the inventor, Bosshardt, and, as it is to be established at Leeds, it is arousing a great deal of interest in the steel-producing centers of the North. Prof. J. A. Arnold, professor of metallurgy at the Sheffield University, says that the material is a remarkable product. He was not aware that such a material could be produced so as to forge easily, except in the experimental works at the Sheffield University, but it is certain that Mr. Bosshardt has made it a commercial success.

BUSINESS NOTES

GREAT BRITAIN

THE LARGEST STEEL FLOATING DOCK of Norway, built by the A. S. Framnæes mek. Værksted, Sandefjord, for the Nylands Værksted, Christiania, was successfully tried at the builders' yard in Sandefjord recently. The principal dimensions are: Over-all length over pontoons, 319 feet 8⅝ inches; over-all width over pontoons, 86 feet ⅝ inch; over-all height of side walls and pontoons, 33 feet 9⅝ inches; clear width, 61 feet; maximum draft of vessel to be docked, 18 feet; height of keel blocks, 4 feet; lifting power (maximum), 4,500 tons; time of lift (3,500 tons), two hours. The floating dock, which was designed by Messrs. Clark & Standfield, Victoria street, Westminster, London, is of the self-docking, bolted, sectional type, known as a specialty of this firm. It is divided into three sections by joint chambers, the middle section being rectangular in plan, and the two end sections having their outer extremities built in the form of a point or bow. The machinery consists of three separate installations, one for each section of the dock, and each installation is self-contained and capable of pumping out its section by itself. The three installations are, however, interconnected by means of a common main drain, so that any one installation can, when the three sections are coupled, empty the whole dock. The power supplied is three-phase alternating current at a pressure of 220 volts per phase, with a periodicity of 50 per second. There are three pump motors, each capable of developing 60-brake horsepower continuously when making 418 revolutions per minute. There is one motor, developing 5-brake horsepower for driving the pump for washing-down service. Four electrically-driven capstans are fitted on the top deck, each capable of exerting a pull of 2 tons at a speed of 45 feet per minute. For the outside lighting eight arc lamps, supported by bracket standards on the top deck of each wall, are provided, and three portable distributing boxes for further outside lighting and portable electrically-driven tools. The interior lighting consists of pendant lamps and wall plugs, suitably situated. The installation of the electrical plant has been supplied by the Aktieselskabet Norsk Elektrisk and Brown Boveri, Christiania. The three discharging pumps, as well as the pump for washing-down service, are of the "Invincible" vertical-spindle pump system, and supplied by Messrs. Gwynnes, Ltd., London, E. C.

John Brown & Company, Ltd.—The annual report issued by this well-known firm states that the net revenue of this company for 1908-9 was £204,897, as compared with £218,405 for 1907-8, £234,238 for 1906-7, £223,880 for 1905-6, and £198,-936 for 1904-5. The dividend for 1908-9 is to be at the rate at 7½ percent per annum, as compared with 10 percent for the previous three years, and 8¾ percent per annum for 1904-5. No addition has been made to the reserve fund for the past two years, but the amount carried forward this year is £97,060. The company suffered during the past twelve months from the low price of coal, its colliery results having been disappointing. The trials of the first-class cruiser *Inflexible,* built by the company, were satisfactory, and orders have been received for a second-class cruiser, three destroyers and the machinery and boilers for the first-class cruiser *Indefatigable.*

Messrs. William Simons & Company, Ltd., of Renfrew, N. B., recently designed a powerful suction hopper dredger, fitted with a suction pipe and cutter, which they have styled the "Simons." It embodies some special features, which they have protected. It is claimed for these improvements that a vessel fitted with them will, in most materials, do the same duty as bucket-ladder dredgers. The new dredger has not so many parts as this latter type of vessel, for it works without upper and lower tumblers and without buckets, links and pins, which are liable to wear, and it is expected that the new type will be much less costly to maintain and repair. Economy in maintenance is naturally of the greatest consequence, both to contractors and to harbor authorities, who have to maintain depths of water in channels and waterways, to meet the requirements of the huge ships which are built and are building. In addition to dredging material from a channel the vessel can carry the material dredged to some other point, say, 15 or 20 miles away, and can then lift the material out of its hopper and deposit it on shore or over a quay wall.

MARINE SOCIETIES.

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.
314 Madison Avenue, New York City.

UNITED STATES NAVAL INSTITUTE.
Naval Academy, Annapolis, Md.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS.
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.
207 Bath Street, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

GERMANY.

SCHIFFBAUTECHNISCHE GESELLSCHAFT.
Technische Hochschule, Charlottenburg.

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The Italian armored-plated cruiser *Amalfi* has made some satisfactory trial trips. She steamed for twelve consecutive hours at the rate of 21 knots, her engines working up to 12,940 horsepower.

Messrs. Telford, Grier & Mackay, Ltd., patent signal lamp makers and electrical engineers, of Glasgow, have secured an order to supply the whole of the British fleet with their new patent flashing signal lanterns, which have also been adopted by some of the principal shipping companies. The principal features of this lamp are: A brilliant light from mineral oil without the use of any glass chimney, or other device to take the place of glass chimney; the flashing screen gives full beam of light full depth and length of the lens at each depression of the Morse key.

Messrs. Siemens Bros., Tyssen street, Dalston, are placing on the market a new and exceptionally interesting high-voltage "Tantalum" lamp for direct current, which will give 25-candlepower at an efficiency of 1.7 watts for all voltages between 200 and 240. The general appearance is similar to that of the 32-candlepower high-voltage "Tantalum" lamp, which we think is too well known to need comment. The new lamp, which is strong and durable, should be a great boon to contractors who have hitherto been faced with the problem of supplying private consumers with a comparatively low-candlepower lamp, which would burn direct on high-voltage supply. The demand for these lamps will most certainly be heavy, and large stocks should be laid in as soon as possible. Messrs. Siemens Bros. are issuing a new leaflet, 14B, dealing exclusively with this lamp, and will be pleased to over-print a supply for any electrical contractor or ironmonger on receipt of his trade card.

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RAINBOW
OUT

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Chicago, Ill.—202–210 South Water St
Pittsburg, Pa.—425–427 First Ave.
San Francisco, Cal.—416–422 Mission St.
New Orleans, La.—Cor. Common & Tchoupitoulas Sts.
Atlanta, Ga.—7–9 South Broad St.
Houston, Tex.—113 Main St.
Kansas City, Mo.—1221–1223 Union Ave.
Seattle, Wash.—212–216 Jackson St.
Philadelphia, Pa.—245–247 Master St.
Louisville, Ky.—111–121 West Main St

Indianapolis, Ind.—38–42 South Capitol Ave.
Omaha, Neb.—1218 Farnam St.
Denver, Col.—1556 Wazee St.
Richmond, Va.—Cor. Ninth and Cary Sts.
Waco, Texas—709–711 Austin Ave.
Syracuse, N. Y.—212–214 South Clinton St.
Boston, Mass.—110 Federal St.
Buffalo, N. Y.—379 Washington St.
Rochester, N. Y.—55 East Main St.
Los Angeles, Cal.—115 South Los Angeles St.
Baltimore, Md.—37 Hopkins Place.
Spokane, Wash.—1016-1018 Railroad Ave

Tacoma, Wash.—1316-1318 A Street.
Portland, Ore.—27-28 North Front St.
Vancouver, B. C.—Carral & Alexander Sts.

FOREIGN DEPOTS

Sole European Depot—Anglo-American Rubber Co., Ltd, 58 Holborn Viaduct, London, E. C.
Paris, France—76 Ave. de la Republique.
Johannesburg, South Africa—2427 Mercantile Building.
Copenhagen, Den.—Frederiksholms, Kanal 6.
Sydney, Australia—270 George St.

TRADE PUBLICATIONS.

AMERICA

"The Smooth-On Instruction Book," eighth edition, is just off the press, and will be sent free to any reader mentioning this magazine by the Smooth-On Manufacturing Company, Jersey City, N. J. This book is fully illustrated, and shows many of the different ways in which Smooth-On cements are used.

Beam shears and coping machines for shipbuilders are two new hydraulic tools described in catalogue 74 published by the Watson-Stillman Company, 188 Fulton street, New York City. These tools were designed with the idea of effecting a large saving in the cost of trimming structural steel and plate metal. The beam shears cut any steel section up to 15-inch I-beams, and may also be used as a hydraulic press when the cutting knives are removed. The coping machine will cut webs, flanges or flat metal at any of the odd angles required in ship construction. Both of these machines are operated by a simple foot pressure and seldom need skilled attention.

J-M Brickline asbestos firebrick cement, for setting up bridge walls and inner courses, is described in illustrated circulars published by the H. W. Johns-Manville Company, 100 William street, New York. This is a high refractory cement of semi-liquid consistency already prepared for immediate application in setting up firebrick in every kind of service. In this circular a letter is reproduced from the Iberia Cypress Company, Ltd., New Iberia, La., stating that this cement has given great satisfaction in the furnaces of the company's steamboat *Sadie Downman*, where, at the time the letter was written, it had been in constant use for three months. This letter goes on to state, "Had we known what this material was we should not have lined our furnaces with firebrick, for we think the common red brick would have done just as well."

A catalogue describing the Nash Century steering engine will be sent to any of our readers by writing to the Century Engineering Company, Ogdensburg, N. Y., and mentioning this magazine. This catalogue, just off the press, is full of hints and good advice about steering methods and engines. "The Nash Century is now recognized among experts as the coming device for steering small and medium-sized steam-propelled vessels. With this engine the tiller ropes derive their motion directly from a reciprocating piston. There is no clumsy drum; the machine can be swung from beneath a beam instead of taking valuable deck space; there are no rubbing surfaces under heavy pressure to absorb power and wear out quickly; there are no parts that need constant attention and no parts that are noisy in their action. The first cost is less than that of any other gear that will do the same work, and the first cost is practically the last. The durability of the Nash Century has been proven in service, and it has failed to develop any troubles. You can try a Nash Century engine free for thirty days. If it does not do what we claim send it back at our expense, and the trial need not cost you one cent."

The Joseph Dixon Crucible Company has got out a handsomely illustrated crucible hanger. The center piece is a realistic foundry scene. Brawny, bare-armed men are seen in the red glow of the molding room pouring the molten metal from a Dixon crucible into a mold. The illustration is made from a photograph, and the picture is true to life in every particular. At the top of the hanger is an illustration in black and white of the Dixon plant at Jersey City. The Dixon factories and offices cover nearly eighty city lots. The other illustrations on the hanger show only the Dixon's products that are made especially for foundry and metallurgical purposes, and consist of crucibles, stirrers, boxes and covers used in burning electric light filaments and for case-hardening purposes, mufflers and phosphorizers, brazing crucibles, dipping cups, skimmers, etc. In the way of printing, there are on the hanger some valuable rules for the care and use of crucibles. Probably the following letter, received from a well-known steel foundry, will show better than anything what users of crucibles think of the hanger: "The hanger of panel which we received from you was hung in our foundry as you suggested, and the avidity with which the same was inspected and read, also the comments which followed, bear testimony to the fact that it had at least interested our men. The hints contained on the panel brought to the attention of the men in this way, we believe, carries much more weight than a great deal of our cautioning might do." We shall be very glad to send one of the hangers described to anyone interested. Address Joseph Dixon Crucible Company, Jersey City, N. J.

Catalogues Wanted.—Mr. Y. D. Kumabe, care Superintendent's Department, N. Y. K., Kobe, Japan, writes INTERNATIONAL MARINE ENGINEERING that he would be very glad to receive catalogues from shipbuilders and engineering works in this country. The Nippon Yusen Kaisha is one of the largest shipbuilders in Japan.

Ship and yacht owners, builders and naval architects should write A. B. Sands & Son Company, 20 Vesey street, New York, for this company's handsome catalogue of marine plumbing and fixtures. A free copy will be sent to every one of our readers who will mention INTERNATIONAL MARINE ENGINEERING.

An improved annular steam jet is described in circulars published by H. Bloomsburg & Company, 425 North Carey street, Baltimore, Md., and the claim is made that this device is showing remarkable results in increasing the power of tugboats for speed or towing.

Piston rod and sheet packings are described in a handsomely illustrated catalogue published by the New York Belting & Packing Company, Ltd., 91 Chambers street, New York City. This company makes all styles of packing for every purpose, and a free copy of the catalogue will be sent to any of our readers upon application.

Chapter XVI. of "The Preventing of Corrosion on Steam Machinery," by W. H. Wakeman, appears in the September issue of *Graphite*, published by the Joseph Dixon Crucible Company, Jersey City, N. J. This is one of several articles of interest to users of lubricants, and anyone interested will be placed on the free mailing list by writing to the company and mentioning this magazine.

"The Boat Industry" is the title of Bulletin No. 28 issued by the Carbolineum Wood Preserving Company, New York, Milwaukee and Portland, Ore. This bulletin is published in the interests of Carbolineum, which is a preparation designed as a wood preservative, to protect against teredoes and to prevent the rotting and decaying of ships' hulls, barges, piers, piling, etc.

The Reeves Compound and single-cylinder steam engines are the subject of Bulletin No. 7, issued by the Trenton Engine Company, Trenton, N. J. This catalogue is fully illustrated, and gives a concise description of Reeves engines and of the advantages claimed for them. These engines are designed for direct connection to centrifugal pumps, electric light plants, etc.

Adamantine threading tools are the subject of the 1909 catalogue of the American Tap & Die Company, Greenfield, Mass. Especially noticeable is this company's line of screw plates, for which the claim is made that they have been brought up to the highest state of perfection as to utility, lightness, finish and strength. Readers of the catalogue will observe the head and foot notes relating to each illustration. These notes are short and to the point.

Steel plate ranges for marine use are described and illustrated in a 100-page catalogue published by Hutchinson Bros., 116 North Howard street, Baltimore, Md. Among the steamship ranges illustrated in this catalogue is a steel plate galley range 7 feet 6 inches long, 39 inches deep, with two fires and two ovens. The ovens are 28 by 18 by 16. This range is supplied with guard rails, cross bars, feet and steel flues and with side braces and rods to bolt to the floor.

A new chain pipe vise is described in 1909 catalogue E published by J. H. Williams & Company, Brooklyn, N. Y. This chain wrench is very compact, when folded occupying a space of only 6 by 8 by 8. The action is particularly rapid; the grip is positive, non-crushing, and always renewable by filing the teeth; the chain hugs the pipe half-way round and can't crush. The jaws are all wrought steel, drop-forged, saw-tempered, with hand-made "Vulcan" chain pipe wrench chains. The parts are all warranted and interchangeable.

Punching and shearing machines, universal boiler makers' tools, rolls, etc., are described in a new illustrated catalogue published by the Covington Machine Company, Covington, Va. The company calls special attention to the two-speed gear arrangement shown on pages 8 and 9, to the automatic stop without springs shown on page 11, to the universal plate, bar and angle shears on pages 14 to 18; the same shear combined with a punch, pages 20 to 21; elliptical boring, turning, etc., machine, pages 22 to 24, and a few useful notes on punches and shears on page 27. The Covington Machine Company has recently made arrangements with Mr. C. C. Wais, of Cincinnati, the well-known manufacturer of punching and shearing machines, to take over his entire line of tools.

"Steel vs. Iron Boiler Tubes" is the title of circulars which the National Tube Company, Frick building, Pittsburg, Pa., is sending out. "In commending these tubes to you we do so with absolute confidence. Lap-welded Spellerized tubes are not in their experimental stage. We have used them in our own boilers and locomotives; and, furthermore, severe tests, conducted by many of the leading railway systems in this country for a period extending two and a half years back, have clearly demonstrated the superiority in every way of Spellerized tubes over charcoal-iron tubes. Shelby seamless tubes have been known to the trade for years; consequently little, if anything, need be said regarding their quality. We commend them to those who prefer a seamless tube very soft, ductile and smooth and drawn accurately to size and gage. There are railroads in certain districts which use nothing but seamless tubes, and quite a few use seamless safe ends entirely in the fire-box end of locomotive boilers. Further than this we would say that the United States Government considers the boilers in war vessels of such vital importance that nothing but seamless tubes are used. Even seamless tubes, on which the cost of production is rather high, on account of the many necessary passes over the draw-bench, are no higher in price than the knobbled charcoal-iron tubes; in fact, seamless tubes are sold at about the same price. The steel tube is rapidly replacing the charcoal iron, on account of quality and price, and foreseeing this we have discontinued the manufacture of iron tubes entirely. We are satisfied that either lap-welded Spellerized or Shelby cold-drawn seamless steel tubes will give better service at a decreased cost."

Refrigerating and ice-making machinery is the subject of catalogue published by the Brown-Cochran Company, Lorain, Ohio. "Mechanical refrigeration is a branch of engineering familiar to many, but understood by few. To the many we explain briefly, that all refrigerating machines may be classified in three groups: those employing air as a refrigerant; those employing the mechanical phenomena of absorption and solution, and those using a liquefiable gas. The air machine is clean and odorless, and is somewhat in use on shipboard; but its enormous size, weight and cost and large consumption of power are serious drawbacks to its wider use. The absorption machine is very complicated, liable to destruction, corrosion of parts, and entirely unsuited to small plants or unskilled attendants. Its agent is ammonia, which has a pungent and penetrating odor, that in many cases of slight derangement of apparatus pervades the entire building, driving guests from hotels, destroying articles of food in storage, and, more dangerous yet, injuring and suffocating workmen. Further, it requires more water for condensing purposes than does any other type. The liquefiable gas machine is the most efficient, the simplest and most convenient. The only serious objection to it is the general use of ammonia, sulphur dioxide and ether, all poisonous and vile-smelling gases, some corrosive to common metals, such as copper and brass, and all dangerous to life and property. These require special constructions of a complicated nature to prevent serious discomfort or disaster from slight leakage. The one gas not liable to these objections—carbon dioxide—was not successfully employed in refrigerating machines until the present type of ammonia machines was well established; so that to-day this perfectly non-corrosive, odorless and harmless gas is to most men a new thing for refrigerating purposes."

TRADE PUBLICATIONS

GREAT BRITAIN

The Consolidated Pneumatic Tool Company, Ltd., Palace Chambers, 9 Bridge street, Westminster, S. W. A new edition of their catalogue has been published, dealing with electric tools of all kinds. Among the newer types of tools which the company now supplies is a three-speed pillar drill, also a new type of side-spindle corner drill. Both of these are fully described in the catalogue.

Applebys, Ltd., 58 Victoria street, Westminster, S. W. *Steel Work Plant* is the title of an excellent pamphlet issued by this company. It gives details of their blast furnace charging machines, a special five-motor electric ingot crane, a magnetic lifting overhead traveling crane, a 100-ton electric ladle crane, an 80-ton electric ladle crane, an electric foundry or forge crane, a three-motor overhead traveling crane, open-hearth electric charging machines, a 3-ton steam cantilever tower crane, electric ingot rotating gear for forge cranes, etc. Excellent illustrations are given and a full description of each specialty.

Weldless Chains, Ltd., Gartsherrie, Coatbridge. Pamphlet No. 5 has lately been issued dealing with their universal chain adjuster for shortening, joining or adjusting the length of chains and slings. The list gives prices and full particulars.

Cowans, Sheldon & Company, Ltd., 3 Victoria street, Westminster, S. W. A new edition of this company's catalogue of lifting machinery, etc., has been issued. It is an excellently got-up book, containing 160 large pages, and there are a large number of illustrations. The company make a special feature of electrically-operated cranes of all types, in addition to those operated by hand, steam, hydraulic power and air.

Schmidt's Superheater Company, Ltd., 28 Victoria street, Westminster, London. A very attractive pamphlet on the generation and use of superheated steam in marine practice has been sent out by this company. Also a list of vessels which have been fitted with the Schmidt superheater. From the latter we see that 142 vessels are using superheated steam on the Schmidt system, and forty vessels in the course of construction are to be fitted with it.

BUSINESS NOTES

AMERICA

PRODUCER-GAS ENGINES.—The Page Engineering Company, Baltimore, Md., well known as builders of the Oriole engine, announce an exclusive arrangement for the manufacture of the Straub (patented) scavenging two-cycle marine engines in powers from 25 to 200 horsepower. This engine is offered for service either on gasoline or producer gas. "The average two or four-cycle engine is in a great many ways not adapted for service on producer gas, and a large number of four-cycle engines on the market which might be arranged for service on producer gas would occupy considerably more space with the gas producer in most boats. The cost of the producer equipment would increase the cost of the complete installation from 30 to 50 percent, and at the same time there would be a reduction of about 20 percent of the gasoline-brake horsepower rating of this same size engine. In the aggregate, the purchaser is confronted with a proposition which means greater cost, more space and weight for the producer equipment with the four-cycle engines now on the market. To meet these objections, the Straub scavenging two-cycle marine engines have been under development for six years, the result being an engine which in economy equals the best four-cycle type, and a great reduction in space, weight and first cost; so much so as to make the proposition a practical one for all types of seagoing yachts, auxiliary craft and commercial boats. While it is not possible to go into a full description of this remarkable engine in the space allowed, it certainly is the marine engine development of the decade. The word scavenging indicates immediately that while this engine falls under the definition of two cycle, taking an explosion every revolution, it has nothing in common with the regular line of two-cycle engines now on the market. The burnt gases are completely scavenged or blown out before the charge is introduced, and the latter is so timed that none of it is wasted through the exhaust port. This gives a clean, sweet charge of tremendous power and efficiency. For producer gas a compression of 150 pounds is carried, and to meet the strain thus set up in the engine the base bearings and all working parts are of unusual strength and dimensions. It is evident from the foregoing brief description that the same engine, with a reduced compression to 85 pounds, makes an ideal gasoline engine wherever space cannot be provided for the producer. Here, again, equal economy to the best four-cycle types is obtained with a very considerable saving in weight and space, first cost and repairs. We are sure that the trade will follow with very much interest the development of the marketing of this new type of engine. In the meantime full information can be obtained by writing to the Page Engineering Company, 113-121 East York street, Baltimore, Md."

VESSELS CLASSED AND RATED by the American Bureau of Shipping, 66 Beaver street, New York, in the *Record of American and Foreign Shipping:* American screw, *Iroquois;* American screw, *General E. O. C. Ord;* American screw, *Mars;* American screw, *Lassell;* American screw, *Danville;* American screw, *Evelyn;* American screw, *Jean;* American screw, *Kansas City;* American screw, *Pennsylvania;* British schooner, *Mina German;* American schooner, *Florence Howard;* American tern, *Margaret B. Roper;* American tern, *Bradford C. French,* and British tern, *Omega.*

The Cleveland Steel Tool Company, Cleveland, Ohio, requests us to state that it has entered suit in the United States Circuit Court against the Cleveland Punch & Shear Works Company and W. D. Sayle, of Cleveland, Ohio, in connection with patents on rolled-head punches and split sleeves.

Boston now has the largest pier for commercial purposes on the Atlantic coast. It is 780 feet long and 240 feet wide, and is occupied by the Cunard Line. This pier is one of several to be provided at the East Boston terminal of the Boston & Albany Railroad, and was built for the New York Central & Hudson River Railroad, which leases and operates the Boston & Albany. The New York Central is also building another pier east of this which be a little larger. It will be finished next January, and will be occupied by the Leyland Line.

"Have you a broken piece of machinery?" is the question asked by the Oxy-Carbi Company, 516 Orchard street, New Haven, Conn. This concern does "oxy-acetylene welding in soft steel, semi-steel, cast iron, copper, brass, aluminum, bronze, etc. We rectify errors in pattern making, alter castings with the same metal for refinishing, add on stock to any piece in any shape. Broken engine cylinders, I-beams, axles, automobile frames, teeth in gears and sprockets, expensive machine parts of all descriptions, metal statuary, water backs, boilers, etc., repaired. There is a wide range in repair and new work. We build tanks of steel, copper, brass, aluminum in any shape with welded joints. Welded branches in tubing never loosen with vibration or heat. We also do brazing."

For the purpose of forming an organization of wider scope and greater strength, Benjamin R. Western and W. Hull Western, until Aug. 1, 1909, respectively proprietor and manager of the Manufacturers' Advertising Bureau, 237 Broadway, New York, and Walter Mueller and W. H. Denney, until Aug. 1, 1909, respectively president and treasurer of the Banning Company, 225 Fifth avenue, New York, have organized the Manufacturers' Publicity Corporation. The officers of the corporation are Benjamin R. Western, president; Walter Mueller, vice-president and general manager; W. H. Denney, treasurer, and W. Hull Western, secretary. The offices are located at the Hudson Terminal building, 30 Church street, New York; telephones, Cortlandt, 475 and 476. The advertising interests of the clients heretofore directed by the aforementioned will henceforth be in charge of the Manufacturers' Publicity Corporation.

Any engineer can secure absolutely free, express charges paid, a large can of Keystone grease, a heavy brass grease cup, and an engineer's collapsible lunch box, by writing to the Keystone Lubricating Company, Department V, Philadelphia, Pa., and stating that he saw the offer in International Marine Engineering.

The Ideal pump governor on the *Mauretania* and *Lusitania*. The Ideal Automatic Manufacturing Company, 125 Watts street, New York City, writes us that its pump governors have maintained 700 pounds pressure on the watertight bulkhead doors of both these ships ever since they were placed in commission, and that they are still at it, no repairs having been necessary at any time.

Among the advantages claimed for the wire rope made by the Durable Wire Rope Company, 28 Atlantic avenue, Boston, Mass., are that it will not rust or dry rot, will not freeze, is always pliable, occupies but small space, is as flexible as manila, and will not cut sheaves. This wire rope is made especially for mooring lines, towing hawsers, tiller ropes, rigging, etc.

The high vacuum apparatus used with surface and jet condensers, made by the C. H. Wheeler Manufacturing Company, Philadelphia, Pa., is said to be especially adapted to marine work. The Pratt patent rotrex pump is guaranteed to produce a vacuum within ½ inch of the barometer, and owing to the compact design and elimination of valves and other working parts necessary with the ordinary types of air pumps, it occupies less space and requires less power to operate, while, according to the manufacturer, the initial cost is lower than that of any other vacuum pump on the market.

Among the new exhibitors in the Philadelphia Bourse are the following: L. J. Wing Manufacturing Company, New York, fans and boiler room equipments; Brown & Sharpe Manufacturing Company, tools; August Mietz, New York, gas and oil engines; De La Vergne Machine Company, New York, gas and oil engines and refrigerating and ice-making machines; Hires Engineering Company, Philadelphia, Pa., steam pumps; John G. Horton, Philadelphia, Pa., patent barrels and by-products; Trenton Engine Company, Trenton, N. J., steam and gas engines; American Diagraph Company, St. Louis, Mo., stencil-cutting machines.

THE NATIONAL MOTOR BOAT SHOW will be held at Madison Square Garden, New York, Feb. 19 to Feb. 26, 1910. Correspondence should be addressed to J. A. H. Dressel, 138 West Forty-second street, New York.

A SOUVENIR WATCH FOB will be sent free to any of our readers who mention INTERNATIONAL MARINE ENGINEERING, by writing to the Lindholm Metal Stamping Company, Department K, Camden, N. J. This company makes the well-known Lindholf grease cups. These are stamped and drawn from heavy-gage sheet steel or brass, and the claim is made that they combine lightness with a toughness that resists every strain and shock.

FOR MARINE PRODUCER-GAS PLANTS.—Any of our readers looking for gas engines suitable for use with marine gas producer plants should write the Clifton Motor Works, 234 East Clifton avenue, Cincinnati, Ohio. This concern makes a heavy-duty, four-cycle, 3 to 80-horsepower engine which is designed especially for such use.

A NEW BEARING has been placed on the market by the New York Oilless Bearing Company, 123 Liberty street, New York City. In designing this bearing the manufacturer had in mind the elimination of friction, thus insuring a great saving in power and increase of capacity and also the elimination of oil; besides which, owing to the simplicity of arrangement of the roller-wheel bearing, the old trouble of slip and wear is said to be avoided. These bearings are also dust proof.

BUSINESS NOTES

GREAT BRITAIN

A JAPAN-BRITISH EXHIBITION will be held in London in 1910 at the "Great White City," Shepherd's Bush. This will be the first great exhibition of Japanese products ever held in Europe, and therefore cannot fail to arouse world-wide interest.

MESSRS. CROSIER, STEPHENS & COMPANY, 2 Collingwood street, Newcastle-on-Tyne, exhibited in Toronto, at the Canadian National Exhibit, held Aug. 28 to Sept. 13, specimens of the company's "Cromil" polygon shaping machines and "Cromil" polygon grinding machines, besides a large line of other tools.

THE "PIONEER" PATENT OIL SEPARATOR for the separation of oil and lubricating grease from exhaust steam, is made by David Bridge & Company, Castleton Iron Works, Castleton, Manchester. This separator is stated to be perfectly automatic, to have no parts which can get out of order, to be extremely simple in design.

PUMP MACHINERY FOR NEW PLANT AT ALEXANDRA DOCKS, NEWPORT.—The contract for one of the most interesting pumping plants has just been settled, that for the Newport Docks Company for their new Alexandra docks. The pumping plant proper consists of two main pumps, coupled direct to two triple-expansion steam engines, two separate 500-kilowatt generating sets being installed for lighting and power purposes. These pumps will be capable, when working simultaneously, of pumping 50,000,000 gallons of water from the River Usk into the dock extension in a period of five hours, the average quantity of water delivered during this period by one pump being 80,000 gallons per minute. Owing to the big quantities and comparatively low heads the pumps are dealing with, the average speed will be 90 revolutions per minute. The same pumps will be used for emptying the graving dock which will be built at a future date. In this case the pumps will work against a total head of 42 feet, and will each deliver an average quantity of 100,000 gallons per minute, running at speeds varying from 90 to 120. The maximum power required by each pump during this period will be between 1,100 and 1,200-brake horsepower, from which data it will be seen that the pumps will be the biggest dock pumps hitherto built. Two schemes differing in principle have been carefully weighed with regard to this pumping plant. The question was whether the pumps should be driven direct by steam engines or whether electrically-driven pumps should be installed, and it was decided that the direct steam-driven pumps would give much greater economy under the existing conditions. This is due to the fact that steam engines are more adaptable to the different loads at the respective speeds which must be provided for in view of the varying heads against which the centrifugal pumps have to work. The main contractors for the whole of the scheme are Messrs. Cole, Marchent & Morley, of Bradford, while the pumps are being built to the designs of Messrs. Jens Orten-Boving & Company, of 9½ Union Court, Old Broad street, London, E. C., by Messrs. Willans & Robinson, of Rugby.

TRADE PUBLICATIONS.

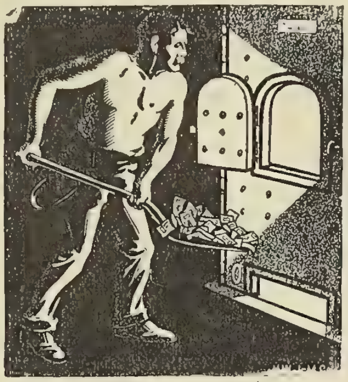
AMERICA

The American Blower Company, Detroit, Mich., is distributing catalogue 259-E, describing its vertical, enclosed, self-oiling engines, ventilating and heating by the blower system; mechanical draft apparatus for steam boilers, etc. This catalogue is being reproduced in Spanish and Portuguese for Latin-American circulation.

The B. F. Sturtevant Company, Hyde Park, Mass., has ready for distribution a new general catalogue No. 165, showing its complete line of fans, blowers, dust collecting and conveying systems, fuel economizers, engines, motors, turbines, etc. Principal dimensions and other useful information are given. Purchasing agents, engineers, superintendents, or anyone interested will be supplied on request.

"A 12-page booklet of envelope size has just been issued by the Joseph Dixon Crucible Company, describing its facings for various kinds of work. The purchasing agent will be glad to know that the listings include prices. Some general information in brief on the proper use of facings, values of different kinds, working conditions met in foundry practice, and so forth, occurs in the booklet. How a facing actually behaves in the mold is accurately described by an analogy to a drop of water on a red-hot stove. It is explained how the water itself never comes in actual contact with the hot surface—but send for the booklet and read all about it. Just address the Joseph Dixon Crucible Company, Jersey City, N. J."

Morris metallic packing for stationary and marine engines, gas engines, locomotives, pumps, air and gas compressors, etc., is described in circulars published by H. W. Johns-Manville Company, 100 William street, New York City. This packing is made of especially treated soft gray cast iron, which, when well lubricated, develops a blue, glazed skin, which is said to defy both time and use to wear through, and which is impervious to the great heat of the high steam pressures now used. Morris metallic packing is sold subject to thirty days' trial, and the H. W. Johns-Manville Company will accept its return at the end of that time if found defective. The packing is also warranted, if accepted after thirty days' trial, for a period of three years from date of installation.



Marine pumps are among the many pumps described and illustrated in a handsome catalogue issued by the Union Steam Pump Company, Battle Creek, Mich., manufacturer of steam, electric and power pumps, condensers and pumping machinery.

"Solid Wedge vs. Double Discs" is the title of a booklet on gate-valve design published by the Nelson Valve Company, Chestnut Hill, Philadelphia, Pa. A free copy of this booklet will be sent t o any of our readers who will mention this magazine.

Price List No. 65 has been issued by the Rome Brass & Copper Company, Rome, N. Y. This is a very complete list of roll and sheet brass and bronze, brass and bronze rods and angles, brass and copper tubing, seamless brass tubes, iron pipes, etc. Many useful tables are also contained in the catalogue, showing the difference between iron gages, fractions of an inch reduced to decimal equivalents, approximate weight of copper and brass, iron and steel plates by American gage, etc.

Repairs to broken rudder posts, anchors, engine cylinders, etc., made by the Thermit process are illustrated in a booklet issued by the Goldschmidt Thermit Company, 90 West Street, New York City. The company undertakes by contract the repair of broken stern posts, rudder posts, stern frames and rudder frames in the United States or Canada, the Thermit process permitting such repairs to be made within three days' time without removing the broken part from the vessel.

Packings made by Morgan & Wright, Detroit, Mich., for marine and stationary power plants are described in an illustrated catalogue this company is distributing. These packings are made for steam, water, ammonia and all other purposes, a special type being provided for each use. The company's "Triangle" cross-expansion piston rod packing is stated to be especially useful in uneven stuffing-boxes, where it fills out every space, the slightest pressure from a gland causing it to expand.

The Trill Indicator Company, Corry, Pa., has just issued an attractive 44-page booklet describing various types of indicators. This book also describes the "Faultless" reducing motion, Trill planimeter and indicators for high-pressure and ammonia work. Besides the description of the apparatus, interesting discussions are given on numerous cards and the causes of various unusual curves pointed out. A method is also given for drawing adiabatic and saturation curves. There is also a chapter on indicating gas engines, with discussions of faulty diagrams and a chapter on indicating compound engines and drawing combined cards.

The Admiral anchor, made by the Baldt Steel Company, New Castle, Del., is described in a handsomely illustrated catalogue just issued, a copy of which will be sent free to any of our readers upon application. "The Admiral anchor is Fred Baldt, Sr.'s latest patent in stockless anchors, and has been on the market since January, 1901. It is noted for its simplicity of construction and great strength, will take hold with both flukes simultaneously, and will not roll from side to side, nor will it break the mud going into it, as the flukes are parallel wih the shank and make a straight pull. Another great advantage is that it will not foul and will house up close to the ship's side in the hawse pipe. This anchor is made in all sizes from 40 pounds to 17,000 pounds, and possesses features that make it a superior article in stockless anchors, which accounts for its rapid rise to popularity. It has been accepted as a leading anchor by all the large shipyards in the United States. All sizes in stock up to 8,000 pounds."

The finished crank shafts and connecting rods made by the Standard Connecting Rod Company, Beaver Falls, Pa., are the subject of an illustrated catalogue this company has issued. "For the information of our patrons would state we have no stock designs nor sizes to offer. All of our product is made to order only from blue prints or detailed drawings furnished us, and supplied only finished ready for use. The many advantages of this system appeal equally to the largest corporation and the smallest manufacturer, as it possesses the following points of merit: You can get exactly what you desire to meet your special requirements, in any quantity. You are relieved of all annoyance, delay and possibility of loss in procuring forgings one place and endeavoring to finish them in your own shop. You avoid the expense of equipping part of your plant with machinery for doing the work, which could be used to greater profit and advantage. You assume no responsibility whatever in the production of these articles other than to specify what you want. You get the benefit of our years of experience, special facilities and ability. You are certain of getting the highest quality of material; most accurately finished and reliable crankshafts that machinery, brains and experience can produce by up-to-date methods."

A valuable book of high-grade engineering appliances. The Lunkenheimer Company, Cincinnati, Ohio, will send a free copy of its *Red Boow No. 46* to any engineer who will mention this magazine. The company asks why anyone should waste his time hunting through a number of other catalogues when by simply consulting the index of this book he can immediately find what he wants in the line of engineering appliances of all sorts.

The result of a test of a Terry steam turbine, by Commander C. W. Dyson, U. S. N., was published in the *Journal* of the American Society of Naval Engineers in August, 1909, and has been reprinted in pamphlet form by the Terry Steam Turbine Company, 90 West street, New York City. The result of these tests shows that the Terry turbine is especially adapted for use in naval and merchant marine service for dynamo drive and for forced draft blowers, etc.

High-speed fans are the subject of illustrated folder No. 208, published by the Conveying Machinery Company, 120 Liberty street, New York. The statement is made regarding this company's turbine fans that "Our turbine fan is the outgrowth of a persistent demand for a high-speed fan which can be attached direct to the shaft of a steam turbine or high-speed motor. Many attempts have been made to provide a unit of this character with fans as ordinarily constructed, but without success. The turbine fan, as built by us, is not a new machine, it being a development of the Robinson type of blowers, which has been extensively used for mine ventilation for ten years past. The cut of the wheel shown here illustrates its design and construction. The curved radial main blades have their outer edges projecting beyond the fan casing, and are curved forward as well as in the line of travel of the air. This not only prevents any spilling of air or gases off these blades, but also eliminates all dead spots in the inlet, as the blades gather in the air for their entire length. The main blades are attached at their base to a cone-shaped hub, with the surface curved to gradually guide the gases to the periphery, thus insuring equal density over all parts of the delivery of wheel. This curved hub is made tangent to a steel plate disc, to which it is securely riveted. The annular ring outside the wheel is cut from a steel plate, and is in one piece. Between this plate disc and the annular ring the auxiliary blades are carried, as shown. It is obvious that these wheels can run at approximately as high speeds as a motor or a steam turbine, the limit being the conditions of volume and pressure of the air at the periphery of the wheel."

TRADE PUBLICATIONS

GREAT BRITAIN

The Riley patent vertical watertube boiler, made by Riley Bros., Ltd., Stockton-on-Tees, is described in illustrated circulars this company is distributing. "This boiler, which is of the watertube type, has been designed and patented to meet the demands for a vertical donkey boiler which is simple in construction, reasonable in price, durable, easily cleaned and repaired and economical in fuel. The shell of the boiler is cylindrical, and is made up of two plates, the lower one into which is placed a circular tube plate and the fire-box, and the upper one to which is attached the crown of the boiler and the upper tube plate. The space between the tube plates, which is closed in by a firebrick back, asbestos-packed doors, and the smoke-box, and is the full length of the tubes, forms a large and free combustion chamber. The fire-box is of the hemispherical form, the products of combustion are led by an incline tube into the combustion chamber, and after passing at right angles among the small tubes, and being split up by the central tube, are then discharged into the smoke-box at low temperature. All parts of the boiler are fully accessible for cleaning, the occasional use of a steam blast through the casing doors being all that is necessary to keep the tubes and tube plates free from soot and dust. Every part of the boiler exposed to the hot gases is covered with water, and can be easily repaired or renewed. All tubes are straight, vertical and of equal length, and can be withdrawn into the upper steam and water space. The boiler is uniform in temperature, has good circulation, a large water area for the liberation of steam, low funnel temperature and high efficiency of heating surface. Easy access to the lower end of the tubes and to the fire-box top is obtained by means of the large central tubes, which form a passage through the combustion chamber. The pressure is safely carried with the minimum thickness of material. During the test of a 5-foot 6-inch diameter boiler (under ordinary working conditions) 100 pounds of steam was raised in one hour from cold water. Water evaporated per pound of coal per hour from and at 212 degrees F., 9.1 pounds."

A price list of hose for all purposes, vulcanized machine belting, rollers, steam packing, rubber gloves and moulded goods, and other india rubber goods, has been issued by the India Rubber, Gutta Percha & Telegraph Works Company, Ltd., Silvertown, E.

The Birmingham Small Arms Company, Ltd., Sparkbrook, Birmingham, have brought out a new catalogue of engineers' small tools. Twist drills, solid and adjustable reamers, shell-reamers and a variety of milling cutters, angular cutters, gear cutters and hobs, and cutters for special purposes are described. All the cutting tools are made in both carbon and high-speed steels. Taper sockets, cutter arbors, lathe mandrels, snap and cylindrical gages, and several pages of useful tables complete the list.

Alley & MacLellan, Ltd., Glasgow, have just issued an excellent little catalogue dealing with their "Sentinel Junior" high-speed engines. In the first section it details the uses for these engines, followed by a general description, and after this the special features are shown. Other sections of the catalogue are devoted to "Sentinel Junior" dynamo and fan engines, dimensions, prices and weights of simple and tandem compound engines, powers at various pressures of tandem compound engines, dynamos for "Sentinel" engines, boilers for "Sentinel" engines, larger "Sentinel" engines, etc. Reference is also made to the company's other manufactures. The catalogue is admirably illustrated, and, among many other illustrations, views are given of the latest extensions to the Polmadie works.

A catalogue published by the Standard Piston Ring & Engineering Company, Ltd., Premier Works, Don Road, Sheffield, states that the spring of the piston ring manufactured by this company combines the necessary vertical and lateral actions better than any spring which has been put before engineers. "Notice the large amount of bearing surface on the springs acting on the piston ring flanges. These springs produce the maximum amount of vertical pressure against the piston flanges—just where it is wanted—enabling the rings to be worked at the very highest pressures and speeds. They have liberal bearing surfaces, can be adjusted to a nicety, and may be relied on to keep the ring steam tight with the minimum amount of friction on the cylinder walls. Their action is simplicity itself, and as there is nothing to get out of order they will last an indefinite period."

The Carbon Cement Company, Ltd., 148 St. James' street, Kinning Park, Glasgow, is distributing circulars describing its boiler and pipe coverers. This concern manufactures all kinds of non-conducting materials, and makes estimates for covering boilers, cylinders, steam pipes, etc. Especial attention is directed to light-weight cements for light-draft steamers, which are stated to be unsurpassed for high, non-conducting properties, great durability and lowest specific gravity.

Laurence, Scott & Company, Gothic Works, Norwich, have published a list of adjustable speed motors which the company has got out particularly for the use of machine-tool makers, having specialized for some years past in adjustable speed motors for direct-driven tools. These motors are sometimes called variable speed motors, but Laurence, Scott & Company prefer the word adjustable, as the word variable also applies to series-wound motors, in which the speed varies automatically with the power.

Lancaster & Tonge, the Lancaster Works, Pendleton, Manchester, have issued a circular dealing with limit piston rings. A projection on each ring of a pair fits into a corresponding recess in its fellow ring. The rings are turned to cylinder gage, and the projections and recesses fitted, after which the rings are cut through at the projection. The recess prevents the rings from opening out beyond the size. The excellent qualities of these rings will be judged from the fact that in one instance, where an engine required piston rings every few weeks, with the Lancaster no adjustment was necessary after three years.

Campbells & Hunter, Ltd., Dolphin Foundry, Saynor Road, Leeds, have issued a circular dealing with horizontal drilling, tapping and staying machines for marine boilers. The spindle is carried by a balanced saddle on a vertical column, which has a transverse horizontal motion on the bed of the machine. The saddle can be raised and lowered and canted, the swiveling motion being controlled automatically, so that the spindle always points to the center of the boiler. Stay holes in boiler backs, through both shell and combustion chamber plates, can be drilled and tapped by these machines, and they are also used for screwing the stays into position, and also for tapping stay-tube holes through both plates at once, and screwing in the tubes. Double-column machines are supplied, each column being independently driven.

BUSINESS NOTES

AMERICA

THE LEBANON CHAIN WORKS, Lebanon, Pa., on Sept. 21 received orders for chain from the Lighthouse Department as follows: Lot No. 1, chain for buoys, 350,000 pounds; lot No. 2, chain for buoys, 430,000 pounds; lot No. 3, chain for light vessels, 300,000 pounds; lot No. 5, bride chains, fifteen, complete. Also lately received order for two lots of chain for the Panama Canal.

THE NASH-CENTURY STEERING ENGINE was invented by a marine engineer who set about to improve on the steering devices in use. "There are certain faults in engines of the two-cylinder type which manufacturers do not seem able to eliminate—ask any user about the steam consumption, attendance, noise, lost motion, wear, size and weight. Other inventors have realized the possibility of overcoming these objections by actuating the tiller ropes directly from the reciprocating movement of a single piston under steam pressure, but until the perfection of the Nash valve motion, of which we exclusively control all patents, none had been successful. Yet the Nash-Century cannot be said to be an experiment, for in its crudest forms the gear has given very satisfactory service in a number of steamers. Those installed on Canadian lighthouse service boats have shown themselves such a decided improvement on the gears which they replaced that we have received repeat orders from the Canadian Government. In every installation the Nash-Century engine has caused no delays or annoyance to attendants, and the expense for maintenance has been confined to occasional oiling and repacking. Since obtaining control of the patents we have secured the services of the inventor, of the best marine and mechanical engineering talent, and of mechanics who are capable of turning out the best product obtainable with modern methods and equipment. Together we have developed a steering engine that within its limitations is as far ahead of the others as the modern ocean greyhound is of the first trans-Atlantic steamer. Under our direction the Nash-Century engine has been brought to the highest state of mechanical efficiency, and it is put upon the market with every assurance and guarantee as to its performance."

THE SUBMARINE SIGNAL COMPANY, 88 Broad street, Boston, Mass., states in Bulletin No. 35 that the company has recently received an order from the United States navy for the equipment with receiving apparatus of fourteen ships, and for the equipment with sending and receiving apparatus of fourteen submarine boats. This makes a total of fifty-one United States naval vessels already equipped with these submarine signals.

THE GENERAL ELECTRIC COMPANY reports very gratifying sales of tantalum lamps. "The sales of this lamp are more than double what they were a year ago, and the lamp appears to be sharing with the demand for high-efficiency lamps created by the introduction of tungsten lamps. The tantalum lamp, as at present supplied, is giving most excellent life service. Contrary to general belief, these lamps will give good commercial life on alternating current of 60 cycles or less. Their life on this frequency will average well above 600 hours. An interesting order recently received for tantalum lamps was for 1,900 lamps for the United States war vessels attending the Hudson-Fulton celebration in New York."

LINOLEUM CEMENT ON WAR SHIPS.—"The world-wide use of cork linoleum has developed the need of a compound which would help the fabric to cling just right to the floor. It is stated by L. W. Ferdinand & Company, 201 South street, Boston, Mass., that they have invented and perfected a glue-cement, which they guarantee will exactly fill the purpose for which it is intended. We are informed by the manufacturers that handlers of this cement make a good profit on it, and that it sells instantly whenever suggested to the customer. The United States Government has adopted and specified Twentieth Century Linoleum Glue-Cement for battleships and for other vessels where linoleum is applied. It comes packed in cans from ¼ pints to 1 gallon. A gallon will cover about 12 square yards where the whole surface is covered; otherwise than this the cement can be used for the edges at a nominal cost. It is made in two grades, grade A being for all kinds of floors, and grade B being for use on wooden floors only. L. W. Ferdinand & Company will gladly supply any department store or carpet house about to issue a catalogue with an electrotype representing a gallon can. They will also furnish any house handling this material with booklets with their name on the outside cover. For directions for laying linoleum on any kind of floors write to L. W. Ferdinand & Company, 201 South street, Boston, Mass."

MR. CLAY BAIRD, representing the Eureka Fire Hose Manufacturing Company in the sale of standard brands of fire hose to fire departments, resigned his position as manager of their Chicago office on Oct. 1.

MR. L. G. KIBBE has resigned as treasurer of the Wheeler Condenser & Engineering Company, Carteret, N. J., in order to take an active part in the management of the Warren Steam Pump Company, Warren, Mass. Mr. Kibbe will be located at the head offices of the latter company at Warren.

MRS. FRANCES A. W. MCINTOSH, 939 Real Estate Trust building, Philadelphia, Pa., lately advertising manager for the Buffalo Forge Company and associate companies, Buffalo, N. Y., and for six years in a similar capacity with the Standard Tool Company, Cleveland, Ohio, desires the preparation of catalogues, folders, ad. forms, direct advertising and follow-up-systems.

A ROTARY ENGINE, made by the Austin Rotary Engine Company, Second avenue and Eighth street, Brooklyn, N. Y., has been installed on the *Columbia*, the coaching yacht of the Columbia University rowing crew. Owners, managers, captains, engineers and others can see this engine in operation by communicating with the company, which states that the engine is frequently subjected to what is regarded as the most severe test of its extraordinary instantly-reversing qualities. "When proceeding at full speed the engines are suddenly reversed, bringing the yacht to a dead stop in ten seconds without any jar, tremor or other unpleasant sensation to those on board."

AT A DIRECTORS' MEETING, held Oct. 2, at the offices of the Welin Davit and Lane & De Groot Company. Con., 17 Battery Place, New York, Mr. C. Sherman Hoyt, naval architect and marine engineer, and for the last year or two inspecting engineer for the Panama Railroad & Steamship Company, was elected secretary and treasurer of the Welin Davit and Lane & De Groot Company, Con. Mr. Hoyt will in future take an active part in the affairs of this company as a member of the firm, both as to the financing as well as the execution of its general business. Capt. John C. Silva, who has resigned from the position of secretary and treasurer, which he held heretofore, is still one of the board of directors of the company, and will in future hold the office of general sales agent. He is about to leave for an extended trip to the Gulf States, where he will attend the National Bar Pilots' meeting at New Orleans, and will thoroughly look into business conditions in the various ports of that district.

NORTON GRINDING WHEELS are made by three processes—vitrified, silicate or semi-vitrified and elastic. In making a vitrified wheel no pressing or tamping is employed. The cutting material and the bond are mixed in power mixing kettles, and the mixture is then drawn off into forming rings. The wheels are subjected to high temperature, nearly 3,000 degrees F., which causes the bond to fuse and vitrify. The personal element does not enter into the making of this wheel. Silicate wheels are made by the tamping process, special machinery being employed in mixing the bond with the alundum. While in a plastic state it is tamped in iron molds. Wheels made by this process are especially adapted for tool and knife sharpening. Elastic or shellac wheels are bonded by gums, such as rubber, shellac and resins. The mixture of alundum and the bond is heated, then pressed in molds. Great strength and elasticity are important factors. It is possible to make wheels by this process as thin as 1/16 inch. They are used chiefly for saw gumming, grinding between the teeth of gears, sharpening molding cutters and woodworking tools, cutting off small stock, slotting and for roll grinding.

THE ALASKA-YUKON-PACIFIC EXPOSITION has awarded grand prizes (highest award) for insulated wires and cables to the General Electric Company and John A. Roebling Sons Company.

THE CHICAGO MOTOR BOAT SHOW will be held March 26 to April 2, in the First Regiment Armory, Sixteenth street and Michigan avenue. Those interested should write to Chester D. Campbell, 5 Park Square, Boston.

MR. H. F. HOEVEL, M. E., has become a director of the Wiener Machinery Company, of New York, and has been elected vice-president and secretary. Mr. Hoevel is a graduate of the famous technical University of Charlottenburg, member of the German Society of Engineers and of the Society of German Steel and Iron Men. Mr. Hoevel has given special attention to study the iron and steel production in its various branches, and before coming to America was connected with the Siemens-Schuckert Electric Works.

HELP AND SITUATION AND FOR SALE ADVERTISEMENTS

No advertisements accepted unless cash accompanies the order.

Advertisements will be inserted under this heading at the rate of 4 cents (2 pence) per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent (½ penny) per word. But no advertisement will be inserted for less than 75 cents (3 shillings). Replies can be sent to our care if desired, and they will be forwarded without additional charge.

BUSINESS NOTES

GREAT BRITAIN

THE DENNY GOLD MEDAL, provided for by the late Peter Denny, LL. D., and awarded each session for the best paper read before the Institute of Marine Engineers, has been awarded this year to Mr. William P. Durtnall (member) for his paper on "The Generation and Electrical Transmission of Power for Main Propulsion and Speed Regulation," read at the Franco-British Exhibition in July, 1908, which was adjudged by the Council of the institute to be the best paper submitted in competition for the medal during session 1908-09.

STOVE'S PATENT HOSE COUPLING.—"This coupling is an improvement by Mr. A. E. Stove, M. I. Mar. E., A. M. I. Mech. E., A. I. N. A., on Nunan & Stove's coupling, which is at present in use in the British, Japanese, Russian, Chilian and Portuguese navies, the Indian Marine, P. & O. S. N. Company, British India, White Star, Cunard and leading steamship companies throughout the world. The old coupling has two sleeves, one revolving over the other, which allows all twist to leave the hose when the water is turned on. It was found that should the sleeve get bent the outer sleeve would not revolve, and consequently a leakage occurred, and again, the coupling was not suitable for suction—the loose sleeve drawing air. A separate coupling, having only one sleeve, was made for this purpose. The present coupling has only one sleeve which revolves, and allows all twist to leave the hose. It is also perfectly tight under all pressures, and can be used both for suction and delivery. If necessary the hose can be riveted to the sleeve, which was impossible with the two-sleeve coupling. The coupling can be taken to pieces immediately and any damaged part replaced. This coupling has been subjected to the most severe tests. Sole manufacturers, Nunan's Hose Couplings, Ltd., 10 Norfolk street, Strand, W. C."

"KEENAN'S SECTIONAL COVERING for steam pipes is now so well known that it seems unnecessary to draw attention to the extreme suitability of it for all steam installations. It can be put on when the pipes are being erected, and when cold; it can be taken off for alterations, and even after years of wear it has been taken off and put on pipes again—thus showing its indestructibility. The sections are made in two pieces, hinged together by means of a stout canvas wrapper, which has a margin to allow of pasting over and making a neat joint and finish. Outside this wrapper are placed bands of varnished steel, or of brass or copper, which hold the section firmly to the pipe. A very neat finish can be obtained by stitching asbestos cloth round the sections, and on battleship work this is the plan almost universally adopted. The sections are molded to suit pipes varying from ½ inch inside diameter up to 14 inches or 15 inches, and are in 3-feet lengths. They vary in thickness from 1 inch for small-sized pipes to 1½ inches to 2 inches for large ones. For superheated steam we recommend the latter thickness. Sections of 1½-inch or 2-inch thickness may be sent out unwrapped, the canvas being applied in a long strip after the sections are placed on the pipes; afterwards putting on the necessary bands. A very good result is got by this method."

MARINE SOCIETIES.

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.
314 Madison Avenue, New York City.

UNITED STATES NAVAL INSTITUTE.
Naval Academy, Annapolis, Md.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS.
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.
207 Bath Street, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

GERMANY.

SCHIFFBAUTECHNISCHE GESELLSCHAFT.
Technische Hochschule, Charlottenburg.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION

NATIONAL OFFICERS.

President—Wm. F. Yates, 21 State St., New York City.
First Vice-President—Charles S. Follett, 477 Arcade Annex, Seattle, Wash.
Second Vice-President—E. I. Jenkins, 3707 Clinton Ave., Cleveland, O.
Third Vice-President—Charles N. Vosburgh, 6323 Patton St., New Orleans, La.
Secretary—Albert L. Jones, 289 Champlain St., Detroit, Mich.
Treasurer—John Henry, 315 South Sixth St., Saginaw, Mich.

ADVISORY BOARD.

Chairman—Wm. Sheffer, 428 N. Carey St., Baltimore, Md.
Secretary—W. D. Blaicher, 10 Exchange St., Buffalo, N. Y.
Franklin J. Houghton, Port Richmond, L. I., N. Y.

TRADE PUBLICATIONS.

AMERICA

"**Holmes metallic packing** is not a new packing but is in new hands, who are determined to supply the consumer with the best packing on the market, and at prices that will cause it to be used and its merits become known." The claim is made in a catalogue published by the manufacturer, the Holmes Metallic Packing Company, Wilkesbarre, Pa., that it does not cut or score the rod, and that when an engine is inactive it will not blister or rust the rod or stem. The packing may be placed in the stuffing-box without disconnecting the rod and in very short time. It is furnished on thirty days' trial, and the rings (the only part that can wear) are guaranteed for one year. The company also guarantees the packing to be steam-tight, and not to score, scratch, blister or wear the rod or stem out of round.

Buffalo machinery is the subject of the 1910 edition of Catalogue No. 178 just issued by the Buffalo Forge Company, Buffalo, N. Y. This is a very profusely illustrated volume of 304 pages, in which is described what is said to be the largest and most complete line of modern-time and labor-saving blacksmith machinery ever offered. These machines are the result of thirty years' experience and knowledge of blacksmiths' requirements. "As the inventors of portable forges and the pioneers in the manufacture of blacksmith machines, we have always kept abreast with the times." Especial attention is called to the portable down-draft and electric forges shown in the catalogue. These were brought out to fill a long-felt want of the average smith and to place him on a competitive basis with the larger shops equipped with power machinery.

The eighth edition of the Smooth-On *Instruction Book* has just been issued by the Smooth-On Manufacturing Company, 572 Communipaw avenue, Jersey City, N. J. This book tells all about Smooth-On iron cements, sheet packings, corrugated metal gaskets, and shows when, where and how to use them. "The great value of Smooth-On to the manufacturer and user is because of its peculiar chemical properties, namely, of metalizing and of expanding when metalizing, and it can be prepared to act quickly or slowly, according to the requirements of particular uses. These properties make Smooth-On a valuable substance in the making of chemical iron cements. To this subject the chemist of the Smooth-On Manufacturing Company has given careful study for fifteen years, and has succeeded in compounding the valuable iron cements known so generally throughout the world as Smooth-On iron cements. These cements are made each for a special purpose; they are carefully prepared by a chemist, and when correctly used they make permanent repairs. The different Smooth-On cements are explained in the following pages; a careful study of them will prove interesting and profitable. The illustrations are made from photographs of actual subjects, and show some of the many ways in which the Smooth-On cements have been used and the results obtained."

Injectors, ejectors, oil and grease cups and other steam specialties are the subject of Catalogue No. 24, published by the Penberthy Injector Company, 342 Holden avenue, Detroit, Mich. "The Penberthy automatic injector has been too long upon the market and is too well-known to the steam user and the steam supply trade to need any introduction or explanation. The auto-positive injector has now been on the market for several years, and has won deserved recognition for its reliability under extreme conditions, while retaining the utmost simplicity of construction. By a peculiar arrangement of the overflow valves it will work on higher pressure and handle hotter water than the Penberthy automatic. In comparing the two styles the question will often arise in the mind of the user: which type of injector will give the best results? In answering this question, not only must the comparative results obtained from the two styles be borne in mind, but also the fact that no injector will give as economical or satisfactory results when working near its highest limit; and, further, as the parts begin to wear its working range is decreased. We, therefore recommend for pressures at 140 pounds and upwards, or where the temperature of the water supply is above 110 at 100 pounds pressure or over, that the auto-positive injector be given the preference. For all other conditions, and particularly for traction engine use, we recommend the Penberthy automatic. Our exact claims for each type of injector will be found under the heading of the respective machines. The information following as to variation in results due to varying conditions, while referring to the Penberthy automatic injector, is equally applicable to the claims made for the auto-positive."

Mechanical rubber goods are described in a handsome catalogue of 130 pages, illustrated in several colors, just issued by the Diamond Rubber Company, Akron, Ohio. Among the products of this company of interest to marine people are packing, hose, valves, gaskets, etc.

The Trill Indicator Company, Corry, Pa., has just issued an attractive 44-page booklet describing its various types of indicators. This book also describes the "Faultless" reducing motion Trill planimeter and indicators for high-pressure and ammonia work. Besides the description of the apparatus, interesting discussions are given on numerous cards and the causes of various unusual curves pointed out. A method is also given for drawing adiabatic and saturation curves. There is also a chapter on indicating gas engines, with discussions of faulty diagrams and a chapter on indicating compound engines and drawing combined cards.

That Plymouth cordage is very highly regarded by vessel owners and captains hailing from our Atlantic coast ports is perhaps not strange, but it may surprise some to know that these goods are in equal favor upon the other edge of the continent. In a recent issue of *Plymouth Products* are shown pictures of two vessels fitted out with Plymouth cordage—one sailing the Atlantic, the other the Pacific. One of these is the big six-master *Addie M. Lawrence*, one of the fine fleet of schooners controlled by J. S. Winslow & Company, of Portland, Me. The other is the schooner *Alice*, one of the crack Pacific coast cod-fishing fleet. When the picture was taken she had, together with a number of her sisters, just received her outfit of Plymouth cordage at the hands of the Pacific Net & Twine Company, Seattle, Wash.

Feed-water filters for marine and stationary boilers are described in a catalogue published by the Ross Valve Company, Troy, N. Y. An illustration is given showing "a feed-water filter, or oil separator, already in extensive use in stationary plants and upon trans-Atlantic and other steamers. Its function is to remove oil from feed water wherever a condenser is used, and the water is used over and over, and has already passed through the engine and carries more or less of the lubricating oil, which it is very necessary to exclude from the boilers. The filter is connected into and forms a part of the feed pipe, being located usually between the feed pump and the boiler. It will be conceded that this filter is very essential to the equipment of a surface-condensing steam engine plant, especially in marine service, where fresh water is not readily available."

Centrifugal pumping machinery is the subject of Catalogue B, published by the Lawrence Pump & Engine Company, Lawrence, Mass. Regarding this company's belt-driven sand and dredging pumps the catalogue states that "they are furnished complete with suction elbow, flap valve and steam ejector for priming. The pump shell is in one casting, very heavy, with extra metal provided in such parts as are most subject to wear. A removable plate is provided on each side of the shell, which gives easy access to the inside of the pump or for the removal of the impeller. The impeller is of the enclosed type, and is of large diameter for moderate speed. The stuffing-box bearing is easily removed from the shaft, and is provided with water injection to prevent sand entering the bearing. The shafts and pulleys are of large diameter. Ample thrust bearings are provided. We supply pumps with steel lining when desired."

Feed-water filtration is the subject of a catalogue published by James Beggs & Company, 109 Liberty street, New York. This catalogue is devoted to the Blackburn Smith feed-water filter and grease extractor for the removal of organic matter, sediment, lubricating oils, etc., from the boiler feed water in marine and stationary power plants. "The Blackburn Smith filter is the only one having small, convenient cartridges, and compelling double friction through two separate and independent filtering surfaces. It is the only filter in which the media can be changed quickly and easily when fouled. On by-passing, opening the sludge valve and lifting the filter cover, the outer cartridges may be removed and replaced by the spare cartridges. Heavy impurities, which may at times cling to the walls of the filtering chamber or settle to the bottom, may be blown out by opening the sludge valve and admitting live steam through the tap for that purpose. Heavier impurities which collect on the outer filtering cloth may be partially removed by reversing the flow. This is done (without shutting down the plant) by lowering both inlet and outlet valves to their lowest limits, opening the sludge valve and then raising the inlet valve by one or two turns. After running long enough in this position to rinse off the outer filtering surface the inlet valve is closed again and the outlet valve opened by one or two turns."

"Water Treatment" is the title of a handsome catalogue published by the Dearborn Drug & Chemical Works, Chicago, Ill. This company makes a specialty of compounds for marine boilers.

Portable tools and machinery are described and illustrated in a catalogue issued by the Stow Flexible Shaft Company, Philadelphia, Pa. The stow flexible shaft consists of a flexible shaft of wire cable revolving within a wire tube, one end of the shaft being connected with the motive apparatus and the other doing the work. It transmits this rotary motion any distance from the power source through any number of curves, thus allowing the power to be carried to the work instead of the work to the power. Among the many uses of this shaft are for attachment to portable tools, such as drills of many kinds, tapping and reaming machines, grinding and polishing tools, stay-bolt and flue cutters, etc.

The C. H. Wheeler Manufacturing Company, Lehigh avenue and Eighteenth street, Philadelphia, makes a specialty of tugboat, ferryboat and dredge equipment. The company manufactures high-vacuum marine surface condensers for steam turbine service, also auxiliary marine condensers, boiler feed, bilge, deck wash, ash ejector and fire pumps, rotary and reciprocating high-vacuum pumps, both vertical and horizontal; of the single, twin and triplex type and of every size and duty, and a special line of feed-water heaters, horizontal and vertical patterns and evaporators. The company publishes, bound in pamphlet form, a number of half-tone cuts illustrating its various products. A free copy of this pamphlet will be sent to any of our readers upon application.

The Reilly multi-coil heater is the subject of an illustrated catalogue issued by the Griscom-Spencer Company, 90 West street, New York City. In this pamphlet is illustrated the 5,000-horsepower Reilly multi-coil feed-water heater installed on the steamship *Comus,* of the Southern Pacific Line. The heater is insulated with a magnesia covering incased in a galvanized iron jacket. In this plant the auxiliary engines, whose exhaust steam is used in the heater, are operated under 5 pounds back pressure, and the feed temperature runs constantly between 220 degrees and 225 degrees F. Only the exhaust steam of the auxiliary engines is used. The claim is made that by the use of this heater a direct saving of 8 to 15 percent in fuel per horsepower is made, and the same percentage is added to the maximum boiler capacity.

Drills are illustrated in a catalogue issued by the Celfor Tool Company, Railway Exchange, Chicago, Ill. This company manufactures drills, reamers and three-lipped drills, Rich flat drills, Celfor, Rich and quick-change chucks, reamer sockets and grinding machinery. "The Celfor drill, manufactured only by the Celfor Tool Company, is a twisted drill, made from a specially rolled section of the best high-speed steel which can be manufactured. The Celfor drill is of unique construction—a construction which gives it marked advantages over all other forms of high-speed drills. That it will accomplish wonderful results—better results than other high-speed drills—and that it is more durable and less costly, we are prepared to prove to those who have not already proved it for themselves. The twisting while hot, in a machine especially designed for the purpose, of a flat bar of high-speed steel does not impair in any sense the quality of the steel; in fact, it improves it. Tests of the torsional strength of Celfor drills show them to be 47 percent stronger than the torsional strength of the flat bar of which they are made."

One of the handsomest catalogues of the year is that issued by the Brown Hoisting Machinery Company, Cleveland, Ohio. This is a 200-page cloth-bound volume, beautifully illustrated with half-tone engravings, many of them being 18 by 6 inches in size. The Brown Hoisting Machinery Company are engineers, designers and manufacturers of complete plants for the rapid and economical handling of coal and other material, and their catalogue shows some representative plants which the company have designed and built, and illustrates the adaptability of the Brown system to widely varying conditions of work. Among the half-tone illustrations are those showing a "Brownhoist" electric gantry crane at the plant of the American Shipbuilding Company, Lorain, Ohio; a "Brownhoist" gantry crane with cantilever extension at the American Shipbuilding Company's plant, West Bay City, Mich.; a "Brownhoist" electric cantilever shipbuilding crane at the Cramp's ship yard, Philadelphia; the same at the Newport News Shipbuilding & Dry Dock Company's yard, and at the ship yards of Harland & Wolff, Belfast, Ireland, and at many other foreign and domestic ship yards. One of the handsomest illustrations in the book is a two-page half-tone, showing a splendid view of the Cramp ship yard during the launching of the United States battleship *Pennsylvania.*

"Plymouth Products" is the title of a series of bulletins issued by the Plymouth Cordage Company, North Plymouth, Mass. This company makes high-grade manila hemp for marine trade. It has been in business for eighty-five years. The company also issues a series of bulletins called *Plymouth Twine News,* which should be read by every twine buyer.

Every draftsman and navigator should send for a free copy of the 1909 catalogue published by the Keuffel & Esser Company, 121 Fulton street, New York, and mention INTERNATIONAL MARINE ENGINEERING. This catalogue is a very complete and profusely illustrated volume of 544 pages, and in it is listed every article that could possibly be wanted by the navigator, draftsman or surveyor, such as compasses, drawing paper, blue printing machines, barometers, drawing boards and instruments of all kinds, planimeters, measuring tapes, drawing in, protractors, scales, sliding rules, transits, levels, etc.

Steam pumps and pumping engines, condensers, evaporators, ash ejectors, etc., are the subject of an illustrated 96-page catalogue issued by M. T. Davidson Company, Tribune building, 154 Nassau street, New York. Regarding the Davidson surface condenser the catalogue states that it is built in strict conformity with United States navy requirements. The Davidson vertical, single-cylinder, double-acting air pump is especially adapted for use on steam yachts, small steamers and in situations where floor space is limited. Many advantages over other makes are claimed for the Davidson machines, and a free copy of this catalogue will be sent to any of our readers who will mention this magazine.

Reilly multi-coil evaporators and distillers, feed-water heaters and condensers are described in illustrated circulars published by the Griscom-Spencer Company, 90 West street, New York. Regarding this company's evaporators the statement is made: "For large plants, where economy of operation is a prime factor, our type B evaporators, arranged in 'multiple effect,' make the most efficient distilling apparatus that can be procured. In this arrangement a number of evaporators are connected in series, the vapor from one passing to the steam coils of the next, where it is condensed in the course of generating more vapor at a slightly lower pressure, which again passes to another evaporator, and the process thus continued until the limiting vapor pressure is reached. This 'multiple effect' operation reduces the amounts of boiler steam and of condensing water to a minimum."

Catalogue No. 10 has been issued by the Eynon-Evans Manufacturing Company, Philadelphia, Pa., engineers, pattern makers, bronze founders and machinists. This is a very complete illustrated volume of 200 pages, describing and illustrating injectors, condensers, blowers, water heaters, valves, cocks, centrifugal pumps, compressed air and circulating pumps, etc.

Any person interested in steel and iron merchandise of any variety will be sent regularly, free of charge, the stock list issued by the Scully Steel & Iron Company, Chicago, Ill., and will also be furnished with a free copy of the company's Blue Book, which is a complete catalogue of iron-working machines, tools and appliances that will be welcomed for the vast amount of valuable tables and reference information that it contains.

The "Diamond" steam flue blower is the subject of the latest catalogue published by the "Diamond" Power Specialty Company, 234 Fort street, West, Detroit, Mich. This flue blower is said to be especially adapted for marine use, and in the catalogue are complimentary letters from the New England Navigation Company, the New England Transit Company, the Milwaukee Tug Boat Line, the Union Steamship Company of New Zealand, and from the chief engineers of a large number of tugs and steamships in this and foreign countries.

A marine type of pop safety valve is described in an illustrated catalogue published by the Consolidated Safety Valve Company, 85 Liberty street, New York City. These valves are made in single and duplex patterns, and are stated to combine new features developed by the high duty demands of modern boiler practice, together with the fundamental principles of construction which made the original pop safety valve famous. The claim is made that the new form of construction gives it a much greater relieving capacity than that of any other valve ever produced.

Hancock valves are described and illustrated in a 40-page catalogue issued by the Hancock Inspirator Company, 85 Liberty street, New York. The Hancock bronze globe, angle, 60-degree and cross valves are made regularly in sizes up to 3 inches. All styles are made with screwed or flanged connections, with plain or yoke type of bonnet. They are made to one standard only for all steam pressures up to 500 pounds. Under actual test, so the catalogue states, the bodies of all these valves will stand a pressure of at least 4,000 pounds per square inch.

"The Foxboro Recorder" is published by the Industrial Instrument Company, Foxboro, Mass., and contains a series of papers about the manufacture and use of instruments, such as tachometers of various types, gages, revolution counters, etc.

Pumping machinery for every service is described in the latest catalogue published by the Buffalo Steam Pump Company, Buffalo, N. Y. This catalogue lists, among many others, ammonia pumps, air and circulating pumps, boiler-feed pumps, bilge pumps, condensers, jet and surface fire pumps, marine pumps, etc.

The points of advantage claimed for the Huxley ball cock, or blow-off valve, made by the Huxley Valve Company, Buffalo, N. Y., are that it is made of bronze, is simple in construction, and has a full, straight opening the size of the pipe from the boiler. It is said to be adapted for all purposes where a quick, full and straight opening and a positive joint are desired, and for any working pressure up to 200 pounds. It is tested to 800 pounds hydraulic pressure.

A comparison of Sirocco with steel plate fans is worked out in a catalogue published by the American Blower Company, Detroit, Mich. The advantages in favor of the Sirocco fan are summarized as follows: "Increased efficiency, resulting in a saving in horsepower for same capacity; increase in capacity of fan for the same power; smaller space occupied for a given capacity, or increased capacity for the same space occupied; slower speed, resulting in quiet operation."

TRADE PUBLICATIONS

GREAT BRITAIN

Campbell patent furnace bars, made by Willock, Reid & Company, Ltd., 109 Hope street, Glasgow, are used on a great number of well-known steamships of all lines. According to a circular just published, the most gratifying results have been obtained by the use of these furnace bars, both in steaming and economy. Their durability, compared with the old style of bars, is said to result in a gain of 95 percent. The White Star liner *Oceanic,* for instance, used about 3,850 bars of the old style in twelve trips. Since the adoption of the Campbell patent furnace bars, however, in the twelve trips only 119 bars were used.

A catalogue of steel boilers and accessories and superheaters for marine and land purposes has just been published by the Central Marine Engine Works, West Hartlepool.

Gold mirrors for searchlights have recently been put on the market by the Reflector Syndicate, Ltd., Grosvenor Mansions, Victoria street, Westminster, London, S. W. These mirrors are described in trade literature the company is issuing, according to which a long series of experiments have been made with glass mirrors coated with gold instead of with silver deposit, the result being, it is said, that the beam of light is practically devoid of the blue and voliet rays of light, being composed of red, yellow and green rays only. The claim is made that for naval projector work it is found that a torpedo boat on a foggy or rainy night can be more clearly seen with a gold than with a silver mirror projector.

The Standard Piston Ring & Engineering Co., Ltd., Premier Works, Don Road, Sheffield, has issued circulars illustrating the position of the oval springs and cone formation of inner faces. The iron of which these rings are made is of a very special quality, of extreme toughness and elasticity. An extract from *Engineering,* descriptive of a test made on a 3¼-inch diameter ring (Ramsbottom type) states: "One of these rings, 3¼ inches in diameter, and having an opening of ⅛ inch, was first sprung open until the opening was 1⅛ inches, the extension being therefore 1 inch. It was again tried, the width of the opening being extended ⅛ inch at a time until it reached 1½ inches."

The third edition of the Consolidated Pneumatic Tool Company's catalogue has been issued. Portable drills, for either direct or alternating current, are illustrated, those of the latter type being suitable for holes up to 2 inches in diameter in steel. The direct-current drills have one, two or three armatures, and are made to take drills up to 3 inches in diameter. The drill is driven through planetary gearing, and a fan on the armature serves to keep the winding cool. A small portable blower, designed to remove the dust from electrical machinery, is illustrated, as also are lifting blocks, coal and ore boring drills, magnetic separators, arc lamps for submarine use, and several types of portable and other grinding machines, all electrically driven. The address of the company is 9 Bridge street, Westminster, London, S. W.

A number of circulars, giving details of their steel chequered plates, steel ship, bridge and boiler plates, sectional steel, has recently been issued by the Consett Iron Company, Ltd., Consett, Durham.

The Carbon Cement Company, Ltd., 166 St. James street, Kinning Park, Glasgow, is calling attention to its boiler and pipe coverers in circulars it has just issued. This company supplied all the non-conducting covering work on the Cunarder *Lusitania.*

David Rowan & Company, marine engineers and boiler makers, 231 Elliot street, Glasgow, have issued a handsome catalogue, profusely illustrated by half-tone cuts, and giving a detailed description of the plant and its capacity. Messrs. Rowan & Company have made the engines and boilers for some of the best-known passenger and cargo vessels.

The Cradley Boiler Company, Cradley Heath, Staffordshire, have issued an excellent catalogue, fully illustrated from photographs of actual boilers manufactured by the firm. Particulars are given of Lancashire, Cornish, Cornish multi-tubular and Colonial boilers, locomotive and marine boilers, and also vertical boilers of several different types, steam-jacketed pans, buoys, etc.

A new catalogue of emery wheels and grinding machinery has been issued by Messrs. B. R. Rowland & Co., Ltd., Climax Works, Reddish, near Manchester. Details are given of emery and corundum wheels, and also of wheels made from a new substance known as carbo-corundum, all of which are manufactured by this firm. Machines of a specially strong nature, for all kinds of wet or dry grinding, are illustrated, including floor and bench grinders, either belt or electrically driven, and tool-grinding machines with fountain tool-rest.

Cammell, Laird & Company, Ltd., recently delivered from their Grimesthorpe Works, Sheffield, to Davy Bros., Ltd., also of Sheffield, a steel press base casting, weighing 56½ tons, which is required for a 4,500-ton forging press which Messrs. Davy are building for the Terni Steel Works, Italy. We understand that Cammell, Laird & Company, Ltd., are also casting a steel entablature for the same press, which will weigh about 51 tons.

Messrs. Charles Winn & Company, Ltd., Granville street, Birmingham, have just published an illustrated catalogue of their gunmetal valves, globe and angle stop valves, with inside or outside screws, renewable seating valves, straightway and parallel slide stop valves, together with check valves, all of which can be supplied with either screwed or flanged ends, are given with prices. A separate list gives particulars of an automatic force-feed lubricator for steam, gas and oil engines and pumps. It is made for both high and low-speed engines. The oil pump of this special lubricator is operated by a cam driven from the engine through worm gearing.

Schmidt's Superheating Company, Ltd., 28 Victoria street, London, S. W., are, we hear, endeavoring to have their superheating system adopted by shipowners in Great Britain. The manager, Mr. A. F. White, has issued a list of vessels on the Continent to which the Schmidt system has been applied during the past six months. The list comprises forty-three steamers, with a total of 22,650 horsepower. We notice the Oldenburg Steamship Company have ten vesels and the Argo Steamship Company nine vessels fitted with the superheater. The results have shown a reduction in coal consumption of 15-20 percent, and as in several instances a cheaper coal has been used since the vessels were fitted with superheaters, the monetary saving has exceeded this.

BUSINESS NOTES

AMERICA

W. M. CORSE, secretary of the American Brass Founders' Association, has taken the position of works manager of the Lumen Bearing Company, Buffalo, N. Y.

THE FIRE which occurred at the works of the Baltimore Oakum Company, Baltimore, Md., on Nov. 3, turned out not to be as serious as was at first thought. It did not stop the operation of the factory, and the damage does not exceed $7,000.

THE B. F. STURTEVANT COMPANY, fan, blower and engine manufacturer, Hyde Park, Mass., has established in its works a branch of the Massachusetts Savings Bank Insurance. The work is in charge of an instructor, who goes among the men, explaining the necessity and value of systematic saving. A large number of the employees have taken advantage of this proposition, arranging for insurance to amounts varying from $500 to $1,000. We believe such movements for employees' welfare are along progressive lines for bettering conditions of all concerned in the industrial world.

HELP AND SITUATION AND FOR SALE ADVERTISEMENTS

No advertisements accepted unless cash accompanies the order.

Advertisements will be inserted under this heading at the rate of 4 cents (2 pence) per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent (½ penny) per word. But no advertisement will be inserted for less than 75 cents (3 shillings). Replies can be sent to our care if desired, and they will be forwarded without additional charge.

For Sale.—Library of technical and theoretical books on naval architecture and shipbuilding, in whole or per volume. Address *Library,* care International Marine Engineering.

For Sale.—Volumes 6 to 16, inclusive, of *Transactions of Society of Naval Architects.* In good condition. Address *Box 21,* care International Marine Engineering.

Wanted to hear from a manufacturer of marine machinery who could take up the special manufacture of a large machine closely connected with ship machinery. Address *Machine,* care International Marine Engineering.

The following vessels have been classed and rated in the *Record of American and Foreign Shipping,* published by the American Bureau of Shipping, 66 Beaver street, New York: American screw *Vulcan,* American screw *Magic City,* American screw *Berwind,* American screw *Hector,* American screw *Bay City,* American schooner *Mary L. Baxter,* American schooner *Melbourne P. Smith,* American schooner *Barbara,* British schooner *A. F. Davison,* British three-masted *Rosalie Belliveau,* British three-masted *Lawson,* American three-masted *Otis,* British three-masted *Jeanne A. Pickels,* British three-masted *Ponhook,* British three-masted *Lavengro,* American three-masted *Frank M. Low,* American bark *Foohng Suey.*

The Page Engineering Company, 113 East York street, Baltimore, Md., announces the opening of a New York office, with J. W. Lowell as Eastern manager, at 100 Broadway, telephone Rector 3296. This company is well known as manufacturers of the "Oriole" motor, and is attracting attention at this time because of the Straub two-cycle scavenging gasoline and producer-gas engines which it is now manufacturing and marketing. "This engine is designed primarily for producer gas from crankshaft to cylinder head, and is certain to give a big impetus to the installation of producer-gas plants, owing to the fact that this type of engine requires less weight and space and costs considerably less for the initial investment and for repairs than the four-cycle types and yet is equal in efficiency and reliability. Mr. J. W. Lowell, the Eastern manager, has had a wide experience as engineer salesman in stationary producer-gas plants as well as marine gasoline engines, and is a strong addition to the sales organization."

BUSINESS NOTES

GREAT BRITAIN

An employment bureau has been instituted by the Society of Engineers, 17 Victoria street, Westminster, S. W. "No fees of any kind are charged, the cost of management being defrayed by the society, with a view to the ultimate benefit of the profession. Qualified engineers of all grades may have their names recorded, though in making a selection from a number of equally suitable men preference is naturally given to members of the society, for whom the register was originally instituted. Only a few names of probably suitable candidates are put forward for each vacancy, so as to facilitate the employer's choice as much as possible. Every effort is made to get personal knowledge of candidates, together with full details of their qualifications, before sending in their names. A number of well-qualified men, representing the various branches of engineering work, are now available, and it is thought that if the register were better known it would be widely used and appreciated by all who require draftsmen, inspectors and other classes of assistants. Employers are invited to send inquiries by telephone or in writing to the secretary, stating their requirements as regards age, qualifications, salary, etc."

MARINE SOCIETIES.

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS.
314 Madison Avenue, New York City.

UNITED STATES NAVAL INSTITUTE.
Naval Academy, Annapolis, Md.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS.
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.
207 Bath Street, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

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Tacoma, Wash.—1316-1318 A Street.
Portland, Ore.—27-28 North Front St.
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Sole European Depot—Anglo-American Rubber Co., Ltd, 58 Holborn Viaduct London, E. C.
Paris, France—76 Ave. de la Republique.
Johannesburg, South Africa—2427 Mercantile Building.
Copenhagen, Den.—Frederiksholms, Kanal 6.
Sydney, Australia—270 George St.